

THE
AMERICAN NATURALIST

VOL. XXXIII.

September, 1899.

No. 393.

A CONTRIBUTION TO THE LIFE HISTORY OF
AUTODAX LUGUBRIS HALLOW., A CALI-
FORNIAN SALAMANDER.

WM. E. RITTER AND LOYE MILLER.

AUTODAX is a genus of salamanders confined, according to our present knowledge, to western North America and almost entirely to California. Three species are known, namely, *A. lugubris* Hallow., *A. ferreus* Cope, and *A. iecanus* Cope. The genus belongs to the Plethodontidae and is undoubtedly close of kin to *Plethodon* itself. *A. lugubris*, the most common and best known of the species, is, however, according to Cope ('89), "one of the most marked species of North American salamanders," and it is an interesting and suggestive fact that all the zoologists who have written concerning members of the genus have noted about them various reptilian characteristics either of structure or habit. Thus, Spencer Baird ('52), one of the earliest observers of *A. lugubris*, the subject of the present paper, mentions the unusual size of the teeth and compares the undulating outline of the mouth to the mouth of the alligator; and Charles Girard ('58) makes the same comparison. Cope ('89) points out these reptilian assimilations in the following

words, his remarks having reference to *Autodax lugubris*: "This is one of the most marked species of North American salamanders. The large temporal muscles give the head a swollen outline behind and separate the derma from the cranium. The latter adheres to the top of the prominent muzzle. The fissure of the mouth is sinuate, most strongly so in adult specimens. On the whole, the physiognomy is not unlike that of the snapping tortoise. I have little doubt that it is more capable of inflicting a bite than any other of the American Urodela."

Dr. John Van Denburgh ('95), who has had much more opportunity than any of the preceding writers to observe *Autodax* alive, makes these statements about the habits of *A. iecanus*: "It usually walks quite slowly, moving but one foot at a time, but it is capable of motion surprisingly rapid for a salamander. When moving rapidly, it aids the action of its legs by a sinuous movement of its whole body and tail.

"The tail of this *Autodax* is prehensile. Several individuals, when held with their heads down, coiled their tails around my finger, and, when the original hold was released, sustained themselves for some time by this means alone. One even raised itself high enough to secure a foothold. This animal's tail is also of use to it in another way. When caught, *Autodax iecanus* will often remain motionless, but if touched will either run a short distance with great speed, or, quickly raising its tail and striking it forcibly against the surface on which it rests, and accompanying this with a quick motion of its hind limbs, will jump from four to six inches, rising as high as two or three."

Most of these observations by Van Denburgh we have many times confirmed in our experience with *A. lugubris*, although we have never seen it jump on a level, nor to so great a distance as that mentioned by this writer. When wishing to pass from an elevated position to a lower level, as, for example, from the hand to the table when the former is held some inches above the latter, instead of falling over the edge in the typical salamander fashion, the creature will frequently execute a well-coöordinated spring and alight on its feet some distance away.

The quickness of movement of *Autodax*, as contrasted with the general sluggishness of the typical salamander, is striking indeed.

Although the illustrations given by Cope (89), p. 184, show fairly well the characteristics of the head mentioned by him, in several respects these are really more marked in fully grown specimens than his figures indicate. We have, consequently, thought it best to supplement his illustrations. Figs. 1 and 2 are dorsal and lateral views of the head of a large male.

The teeth of the projecting upper jaw in adults are distinctly visible when the mouth is closed, their points not being covered by the lip (Fig. 2). Further, their large size causes ridges on the outer surface of the lip. Professor Cope's conjecture that the animal is capable of inflicting a bite is certainly very reasonable, but we have been unable to get any positive evidence on the point.

The species is entirely terrestrial and seems to be indifferent even to a proximity to water. Rotten stumps and logs are the preferred habitations, and wherever these occur in the region about San Francisco Bay, even though at the remotest places from water, specimens are almost sure to be found, and frequently in considerable numbers in or under the same stump. Thus a single stump at Sausalito, Marin County, yielded to one of us seven specimens of one size and five of another size, none of them, however, being fully grown. Those of the smaller size

were about 50 mm. long, and were dark gray, almost black, in ground color, with finely sprinkled bluish silver. Those of the large size were about 75 mm. long, were much lighter in ground color, and were wholly devoid of the silvery specking, but possessed a few relatively large yellow spots

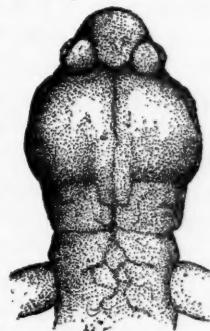


FIG. 1.



FIG. 2.

on the sides of the abdomen. As we now know, the smaller darker ones were of last year's hatching; and in all probability the larger ones were a year older. The presence together of so many individuals suggests that those of the same size all belonged to the same brood; and also the possibility that the two broods represented were both the offspring of the same parent. Of course there was no way of answering this query positively, but one other piece of information that we have obtained confirms the suggestion in so far as it furnishes farther evidence that the young of a brood may remain together for a considerable period after hatching. Some time during March, 1896, a student in zoölogy, whose testimony we regard as reliable, reported to one of us that he had found a fully grown salamander, which, from his description, was undoubtedly *Autodax*, "with a lot of little ones."

The species is decidedly nocturnal in its habits. This is not only proven by the fact that one practically never finds it abroad during the daytime in nature; but also by the alacrity with which specimens kept in confinement in a terrarium seek to secrete themselves during the daytime, but come out and run about freely during the night.

As shown by Wilder, *Autodax* is, in common with so many of the long-tailed amphibians, lungless. This being so, the exclusively terrestrial habit of the animal makes the question of the seat of respiration in this species particularly interesting.

We do not propose to go at length into a discussion of this subject at present, but content ourselves with noting a few observations that support the view recently defended with special emphasis from the morphological side by Bethge ('98), that, in the absence of both gills and lungs, respiration is performed by the mouth epithelium and the integument together, each taking an essential part. This is in opposition to the conclusion drawn by Camarano ('94), in particular, from physiological studies on *Salamandrina perspicillata* and *Spelerves fuscus*, both lungless salamanders. This author believes that the skin participates very little, if at all, in respiration.

The facts which we interpret as meaning that the integument takes an important part in respiration are these: In the

first place, the softness, delicacy, and constantly moist condition of the skin of the entire body, and the abundant supply of blood vessels and capillaries within it, furnish the structural conditions necessary for respiration. In this connection the vascular supply to the toes deserves particular attention.

A great blood sinus is present on each side, and near the end of each of these organs (Fig. 3).

These lakes of blood, as they may be called, become particularly conspicuous in animals that have been anaesthetized with ether or chloroform, though they are easily seen by the aid of a hand lens in the normal living specimens. It is a reasonable supposition that we have here a not unimportant seat of respiration. No portion of the integument is better

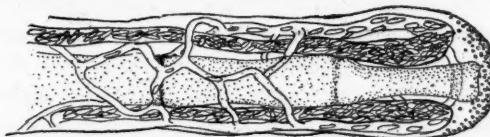


FIG. 3.

calculated to make the most of what little moisture there may be in the animal's surroundings, they being especially adapted to this end both as regards contact with moist bodies and area of surface exposed. The toes, in fact, may be considered to have assumed in a measure the function of external gills.

How generally this vascular condition of the toes is among the amphibia we do not know. In two other species having much the same habits, at least as regards dwelling places, which we have examined, namely: *Plethodon oregonensis* and *Batrachoseps attenuatus*, practically the same conditions are found, while in *Diemyctylus torosus*, the habits of which are quite different, and in which lungs are present, no unusual degree of vascularity is found in the members.

The toe-tips of Autodax are somewhat expanded (Fig. 3), and the animal has considerable power of clinging by means of them to vertical and overhanging surfaces. In this respect it resembles *Hyla* somewhat, and consequently a comparison between the two forms with respect to toe structure is suggested.

Examination of the toes of living specimens of *Hyla* reveals the fact that here also the tips — pads, as they are well known to be in this animal — are rather richer in capillaries than are other portions of the feet and limbs, but the blood sinuses are not present. Schuberg ('91) has made a detailed study of the toes of the *Hyla arborea*, and although he does not particularly discuss the blood supply to the organs, his figures show not only that the sinuses are absent here, but they seem to indicate that blood vessels and capillaries are not especially abundant.

That the pharynx also plays an important part in respiration is indicated by the constant vibration of the region. From 120 to 180, or even more, of these vibrations take place in a minute, and in some cases they are grouped into series of about twenty to twenty-five extremely rapid vibrations, with periods between each two series during which the vibrations almost entirely cease.

The supposition that these vibrations are respiratory is strengthened by the fact that when the animal is immersed in water they cease entirely, the floor of the mouth and pharynx being then held permanently compressed against the upper wall, apparently for the purpose of excluding the water. In this respect *Autodax* differs markedly from *Diemyctylus*, where the pharyngeal floor may or may not vibrate while the animal is out of the water, but always has a constant, though much slower, up-and-down movement during aquatic periods of life, Gage ('91), Ritter ('97).

For the little published information we have regarding the reproduction of *Autodax* we are indebted to Dr. Van Denburgh. On July 25, 1895, this herpetologist received from Los Gatos, Cal., a female specimen of *A. iecanus* with fifteen eggs. A note accompanying them stated that they were found "under the platform in front of a barn, in dry earth next the foundation wall, and about fifteen inches or more below the surface. . . . There was no water within ten or fifteen feet." Dr. Van Denburgh did not hesitate to consider the eggs to belong to the *Autodax*, as he found entirely similar ones in the ovaries of another specimen taken from the same locality on July 30 of the same year. The female accompanying the eggs had

numerous small ovarian ova. The eggs, the author says, were in the early stages of segmentation. Unfortunately, this is all the information he gives us concerning them, and he tells me now that he tried to keep them alive in order to watch their development, but that in this he was not successful.

The specimens upon which our observations have been made were found on the grounds of the University of California by one of the students. They consisted of an adult female and nineteen embryos, all in practically the same stage of development and well advanced. They were found slightly beneath the surface of the ground and close under the oversetting base of a large palm tree.

The student who found them stated that he noticed, as he was loosening the earth about the roots of the palm, a hole which he at first supposed to be a gopher hole, but on removing a little of the soil at this point the salamander and her eggs were brought to light. He says that on being uncovered and disturbed she "squeaked like a mouse." This sound was one of the first things that attracted his attention. This squeak is frequently produced by adults when first taken, but rarely while they are in confinement. They were on the south side of the tree; and as the ground in this palm grove is kept perfectly free from other vegetation, and the spot where the animals were located receives the full force of the sun's heat during the whole middle portion of the day, it will be readily understood, particularly when it is considered that this region had received no rain for at least two months, that the place was about as dry as it can become. There is a creek bed about fifty meters from the tree, but this had been dry for three months at least.

When brought to the laboratory in a box with some earth, the salamander was partly coiled around the eggs, and in this position she seemed at first inclined to remain, since she returned to the eggs several times after being removed. The following morning, however, she had left them and appeared to have entirely deserted her charge. As we had arranged her new habitation in such fashion as to make the conditions as nearly natural as possible, we concluded that it was useless to expect the parent to care any longer for her family, so deter-

mined to take charge of them ourselves, and to make use of her to settle by dissection various anatomical and physiological questions that had arisen.

From the evidence at hand, then, there can be no doubt that *Autodax* lays its eggs not only in the earth, but in earth that may be very dry; that at least most of the development of the embryo takes place after the eggs are laid; and that the female parent remains with her eggs most of the time during the development of the embryo.

For what purpose the female tends her eggs is not entirely clear, but it is almost certain that one end attained is the maintenance in them of the high degree of moisture essential to their development. We supposed, on receiving the embryos and learning of the place where they had been found, that it would be necessary, in order to insure their further development, to place them under conditions of temperature and dryness similar to those by which they had been surrounded in nature. We consequently prepared a terrarium with this end in view, but greatly to our surprise and consternation, on the following morning we found the eggs much shriveled and most of the embryos either dead or nearly so; and it was only by placing them in water and allowing them to remain there for an hour or more that we succeeded in restoring any of them to their former healthy, active state. Four embryos returned to full vigor; and by keeping these on damp earth, and thoroughly wetting them at least twice a day, they continued to develop apparently in a perfectly normal way, to the time of hatching, which was September 13, or about fifty days after they were taken.

How do the eggs in nature get the large amount of moisture necessary to their life and development? Through a long series of observations made under the direction of Professor E. W. Hilgard of the Agricultural Department of the University of California, during the past extremely dry season, it has been proven that plants draw moisture from the soil after a degree of dryness has been reached, which has generally been believed to be incapable of yielding any moisture to vegetation; *i.e.*, after microscopic water is no longer present. It may be that

this fact is not without significance for such animals as our land-dwelling salamanders also. But we can hardly believe that such moisture can do more than prevent evaporation to some extent. It does not appear to us possible that sufficient water to insure the development of the eggs can be derived from this source. Our specimens were always more or less completely covered, and as the earth on which they were kept was constantly wet almost to saturation, and as they were not subjected to the direct heat of the sun at any time during their confinement, the evaporation from them under the artificial conditions could hardly have been greater than that under the natural conditions ; and it appears impossible that any such quantity of water could be drawn from the dry soil in which they were found as it was necessary to give them each day to prevent desiccation.

The possibility that the urine of the parent might be the chief source of moisture to the embryos was suggested by the large size of the urinary bladder, and it is by no means impossible that the suggestion is well founded. However, a study of the structure of the organ and a comparison of it with its counterpart in other species where it is certainly not put to such a service do not confirm the conjecture. The bladder of Autodax does not differ either in size or minute structure from that of Diemyctylus, for example, the young of which are hatched in water. In fact, the bladder of Diemyctylus is of the two-lobed type, while that of Autodax is not lobed, and hence may be looked upon as the simpler of the two.

(See Field (94), for a discussion of the different types of amphibian urinary bladder.)

The Embryos and their Development.

As already said, there were nineteen embryos in our batch. Each was contained in a gelatinous capsule and was firmly anchored to a clump of earth by a narrow peduncle, about 8 mm. long, composed of the same material as the capsule. The peduncles were attached to the earth close together; in fact, their adhesive, expanded, attached ends were more or less confluent (Fig. 4).

The peduncles were twisted, and each appeared to be hollow. The capsules were rather thin and seemed decidedly leathery when the eggs first reached us—as was always afterwards the case if the eggs were permitted to desiccate to any extent. After having imbibed water, however, which they did very eagerly, they became much thicker and more transparent and showed clearly their gelatinous nature.

The capsules were almost perfect spheres, and in what might be considered their normal state as regards imbibed water, were about 6 mm. in diameter. When the capsules were moderately swollen, and their surfaces were washed clean, the black em-

bryos and the very large yellow yolk-sacs could be distinctly seen through them; and many details of structure were studied from day to day on the living specimens as they continued to develop. Figs. 5 and 6 were drawn from living specimens.

Four days after they came into our possession one embryo was dissected from its capsule and was found to be 15.5 mm.

long. Its fore and hind limbs were of nearly equal length and were about 2 mm. long. The toes had not yet appeared. The gills were very large, and were each composed of three broad membranous lobes (Figs. 5 and 6).

The facts of special interest concerning the embryos, and which, consequently, we consider somewhat more in detail, are the following:

(1) *The Great Quantity of Yolk in the Eggs, and the Vitelline Circulation.*—The yolk-sac of the embryo, measurements of which are given above, was 5 mm. in diameter. This is a little more than twice the diameter, or eight times the mass of the eggs of *Diemyctylus torosus*, a species of about the same size as *Autodax lugubris*, but one in which the eggs have about the character, as regards yolk, of amphibian eggs in general. Whether or not the egg is meroblastic we have been

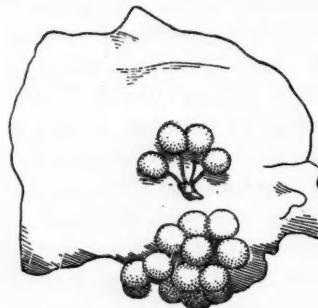


FIG. 4.

unable to determine with certainty, though what evidence we have obtained points to the conclusion that they are of this type. We have been unable to find any trace of either nuclei or other protoplasmic material, or cell boundaries, in the sections of the yolk which we have made. But, of course, earlier stages of development will have to be studied before the point can be definitely settled.

The entire surface of the yolk is covered by a very delicate epithelium which carries the vitelline vessels and capillaries. No pigment is present excepting in the embryo itself.

The general character of the vitelline vessels is shown in Figs. 5 and 6. The vitelline arteries, *v.a.*, are given off from the dorsal aorta in pairs, there being approximately a pair for each myotome of the abdominal region of the embryo. In all there are twelve or more pairs. The vitelline veins collect into a single large trunk (Fig. 5), *v.v.*, situated on the anterior side of the yolk-sac, and corresponding about to the sagittal plane of the embryo. The two trunks seen in the figure at the point of disappearance behind the head become confluent before actually entering the body.

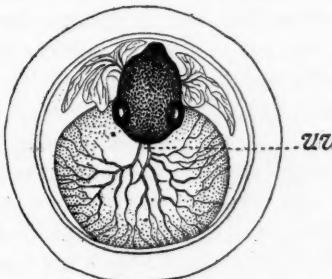


FIG. 5.

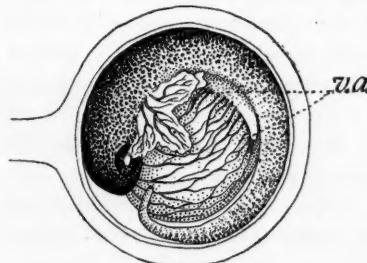


FIG. 6.

(2) *The Gills.*—These are of great size. They are three-lobed, the lobes being thin and delicate, much expanded, highly

vascular, and widely confluent at their bases. The gills are so placed that their dorsal surfaces are close to, and concentric with, the inner surface of the egg capsule (Figs. 5 and 6). As they are functional during the intra-capsular life of the embryo

only, the term *allantoic gills*, first used by Gage ('90), I believe, is strictly applicable here. They begin at once to wither away when the embryo emerges from the capsule, the circulation being apparently cut off from them at that time. We placed one embryo in water immediately after its hatching and kept it there for some time, but could detect no trace of circulation in the gills, though it was always easily seen there during the intra-capsular life.

(3) *The Entire Absence of a Larval Period of Life.*—The young, at the time of hatching, possess none of the characters of aquatic amphibian larvæ. The external gills have, as already said, begun to wither and are not functional after the animal leaves the capsule. The gill-slits are imperforate, at least during the stages examined by us.

No suggestion of a dorsal and tail fin is present at any stage of development that has come under our observation. The tail is at all times as nearly round in section as is that of the adult. The just-hatched individuals, placed in water, appeared much distressed and were quite unable to swim. They sank immediately to the bottom and remained there until removed from the water.

The integumentary sense organs that are apparently invariably present in all aquatic urodele larvæ are, so far as we have been able to determine, entirely wanting here. We have carefully examined the skin both from the surface and on sections, and for various stages of growth, and always with negative results. Fig. 7 represents a specimen shortly after its escape from the capsule. The gills have almost entirely disappeared, and the abdominal walls are nearly closed over the yolk-sac. This specimen was 32 mm. long at hatching.

The color characters which distinguish the young during the first year have already been described. These are already assumed before escape, and are retained apparently until some time during the second year, when the almost black ground-work is changed to the dusky brown of the adult, and the fine silver specking is replaced by the much larger and less numerous yellow spots that mark the sides of the body of many of the adults.

In concluding this fragmentary contribution to the life history of this interesting salamander, we may remark that we are now directing our efforts to the securing of material, particularly embryonic material, that will enable us to complete the story. In the meantime we may call attention to some of the exceedingly interesting, but equally difficult problems of adaptation that are presented by our California salamanders.

The species of Autodax appear to be among the most terrestrial of American Urodela.¹ They are, nevertheless, lungless, and are possessed throughout life of a delicate, smooth, moist skin. *Diemictylus torosus*, on the other hand, which has practically the same geographical range, and hence is subject to the same climatic conditions, while being thoroughly aquatic for a considerable portion of its life, has developed an exceedingly hard and rough epiderm well fitted to resist desiccation; and, besides, it possesses well-developed lungs. In other words, the adaptive modifications in the two forms have gone in directions opposite to what might have been expected. We should have supposed that whatever the immediate influences may have been which caused the disappearance of the lungs, these would have been most potent in animals that passed the most of their time in water; and we should likewise have supposed that it would be just the animals that lived exclusively on land, in the air, that would have taken on the dry, hard, rough epiderm. And the case is the more puzzling from the certainty which we have, Wilder ('94), that in some species at least, and hence inferentially in all, the lungless condition is secondary and



FIG. 7.

¹ Wilder's ('99) recent interesting paper on *Desmognathus fusca* and *Speleopetes bilineatus* shows that the former species approaches Autodax in this regard, but here there is a true aquatic larval period despite the fact that the eggs are laid on land. *Plethodon oregonensis* and *Batrachoseps attenuatus*, two geographical neighbors to Autodax, will be found, we are quite convinced, to be entirely terrestrial; but full evidence on the point is not yet at hand. And Wilder ('94) gives reason for supposing that *Plethodon erythronotus* is entirely terrestrial.

not original. Were we permitted to suppose that the lungs had never existed in these species, we might then assume that the low grade of respiration required by the animals was taken on by the integument and buccal cavity when the gills disappeared, so easily that there was no particular demand for the production of lungs. But that *lungs already present should be lost by an air-breathing animal, and should be retained by a closely related water-living animal, is remarkable.*

BERKELEY, CALIFORNIA, April, 1899.

'52 BAIRD, SPENCER. Iconographic Encyclopedia, Vol. ii, Botany, Zoölogy, Anthropology, and Surgery.

'98 BETHGE, EMIL. Das Blutgefäßsystem von Salamandra maculata, Triton taeniatus, and Spelerpes fuscus; mit Betrachtungen über den Ort der Athmung beim lungenlosen Spelerpes fuscus. *Zeitschr. f. wiss. Zool.* Bd. lxiii, pp. 680-707.

'94 CAMERANO, LOR. Ricerche anatomo-fisiologiche intorno ai Salamandridi normalmente apneumoni. *Atti della R. Accad. della Scienze di Torino.* Vol. xxix. 1894.

'89 COPE, E. D. Batrachia of North America. *Bulletin of U. S. Nat. Museum*, No. 34.

'94 FIELD, H. H. Morphologie de la vessie chez les Batraciens. *Bull. de la Société Zoologique de France.* 1894.

'90 GAGE, S. H. Changes in the ciliated areas of the alimentary canal of the Amphibia during development and the relation to the mode of respiration. *Proc. Amer. Assoc. Adv. of Sci.* Vol. xxxix, pp. 337, 338.

'91 ——— Life history of the Vermilion-spotted Newt (Diemyctylus viridescens Raf.). *Amer. Nat.* Vol. xxv, pp. 1084-1110.

'58 GIRARD, CHAS. Herpetology. *United States Exploring Expedition.* Vol. xx, with Atlas.

'97 RITTER, WM. E. The Life-history and Habits of the Pacific Coast Newt (Diemyctylus torosus Esch.). *Proc. Calif. Acad. Sci.* 3d ser., Zoöl. Vol. i, No. 2, pp. 73-113.

'91 SCHUBERG, A. Ueber den Bau und die Funktion der Haftapparate des Laubfrosches. *Habilitations-Schrift.* Wiesbaden. Pp. 1-62.

'95 VAN DENBURGH, JOHN. Notes on the Habits and Distribution of Autodax iecanus. *Proc. Calif. Acad. Sci.* 2d ser. Vol. v.

'94 WILDER, HARRIS H. Lungenlose Salamandriden. *Anat. Anz.* Bd. ix, pp. 216-220.

'99 ——— Desmognathus fusca (Rafinesque) and Spelerpes bilineatus (Green). *Amer. Nat.* Vol. xxxiii, pp. 231-246. March, 1899.

THE WORCESTER NATURAL HISTORY SOCIETY.

HERBERT D. BRAMAN.

IN 1854 some of the members of the Worcester Young Men's Library Association, leading spirits among them being Thomas W. Higginson and Edward Everett Hale, formed a branch for the study of natural history. Later the association gave its books to the city library and became "The Worcester Lyceum and Natural History Association," whose objects were: "The diffusion and promotion of useful knowledge among the inhabitants of the city and county of Worcester: (1) by courses of popular lectures; (2) by encouraging the study of natural history, and by the collection and preservation of specimens in the various departments, together with a library with a view to that end." Later the present name was taken.

Any resident of Worcester County, above the age of fourteen years, could become a member. The present membership is sixty, the fact that the privileges are free to all, keeping the membership small.

The charter of the society has just been changed by the present legislature, limiting the managing membership to fifty and providing for an unlimited associate membership, the details not having been fixed as yet.

Acting upon the advice of Louis Agassiz, regarding a collection, it has been the purpose of the society to gather and preserve such specimens as shall represent the life history of each species of the animals and vegetables in Worcester County, also its rocks and minerals; further, to illustrate from outside localities the subkingdoms of organic and inorganic matter.

The collection which has resulted consists in part of: Mammals, 63 species, 40 from Worcester County; birds, 400 species, 234 from Worcester County, with nests and eggs of 120 species; reptiles, 50 species, 25 from Worcester County; fishes, 70 species, 12 from Worcester County; insects, includ-

ing spiders and myriopods, 2434, from Worcester County; crustacea, 11 species, 3 from Worcester County; mollusks (represented by shells), 1500 species, 4000 specimens, 33 from Worcester County. Echinoderms and corals are well represented, and the lower forms by a collection of microscopic slides.

From the vegetable kingdom, pressed specimens (Worcester County, except some of the *algæ*), there are: Seed plants, 600 species; ferns, club mosses, etc., 40; mosses and liverworts, 148; fungi, 34; *algæ*, 137 (almost wholly marine); diatoms (slides), few.

The inorganic kingdom is well represented by about 2000 specimens; rocks and minerals from all parts of the world, among them being the representative rocks of central and southern Worcester County, and 57 species of minerals from the county.

This material, plainly labeled, is arranged in upright and horizontal cases and drawers in the rooms of the society building, at the corner of State and Harvard streets. The museum is open to the public without charge six days in the week, and is visited by about 6000 people yearly. There is an intelligent custodian in charge, ready to be helpful in every possible way to visitors.

Special displays are made from time to time upon the tables in the larger rooms. For instance, during the early part of last winter a display of the coniferae of Worcester County was made, consisting of sprays of the foliage of each species, with the cones. Later were shown the winter birds of Worcester County — permanent and transient — first the hawk group, then the smaller birds, and finally the game and water birds. Two or three weeks are allowed for such exhibits, and at the same time articles are published in the daily papers describing them. During the past summer and fall the flowers and fruits of the county, as they made their appearance, were brought in and shown, marked with their common and scientific names.

The work is also educational, and the society encourages the use of its material by all interested in any branch of natural history. Its rooms are supplied with tables where one may

study specimens in the collection. It has a small reference library whose books are sometimes loaned. There are also two rooms for special study; one fitted up as a mineralogical laboratory, with gas fixtures, reagents, blowpipes, and other appliances, ready for use at any time; another fitted for use as a botanical laboratory.

For purposes of study, duplicate specimens are loaned as freely as books from a public library, and this is taken advantage of by the teachers of the city schools, who not only borrow objects for their own study, but for use in their class work. There were loaned to teachers and others during the last year: 344 birds, 18 nests, 30 mammals, 72 lots of minerals and rocks, 20 fossils, and a lesser number each of shells, charts, drawings, and books.

The society fosters the study of natural history by its yearly classes, many branches of the subject in the past having been covered. Those arranged for 1899, now under way, are: For the study of birds, two — one for adults, one for children; botany, two — one each for adults and children; elementary biology and microscopy, one; mineralogy, one. The class-room is not large enough to well accommodate the attendance at some of these classes.

The society gives a series of lectures each winter and spring, covering natural history subjects generally. It has also endeavored to popularize nature study by means of interesting articles in the daily papers of the city, on the mammals, birds, fish, frogs, toads, turtles, mollusks, flowers, minerals, and geology of the county, written by its members.

Again, the society aims to make its collection and work useful in all ways, as, for instance, in answering questions that may arise as to the best means of combating harmful plants and animals, and fostering those which are beneficial; also as to the economic values of woods, rocks, etc.

Two pamphlets have been published: *Flora of Worcester County*, by Joseph Jackson, Jr., 46 pp., 1883; and *The Physical Geography of Worcester, Mass.*, by Joseph H. Perry, F. G. S. A., 40 pp., 1898.

The society has invested funds of the par value of \$6,500;

it also receives the income of \$10,000 trust funds, for which it is obliged to give yearly in a neighboring town a course of six lectures on natural history, "at its own expense, by competent and able and well-known scientists." Other sources of revenue are the yearly fees and assessments of members, the renting of land owned by the society, and a "three-year fund" subscribed to by a few men who are willing to help the good work.

The society hopes in the future to work along the line laid down by Louis Agassiz for its collection, and to foster still more the use of its material in useful and educational ways, and for recreation. It only needs money to extend its influence.

SYNOPSIS OF NORTH-AMERICAN INVERTEBRATES.

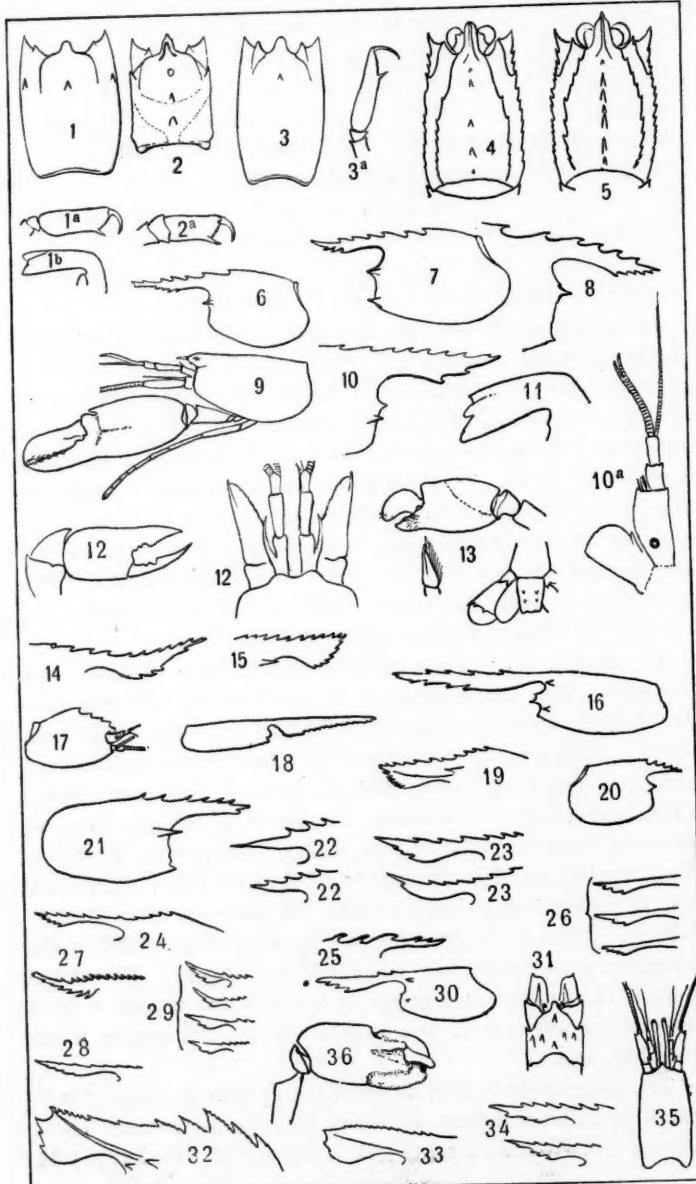
III. THE CARIDEA OF NORTH AMERICA.

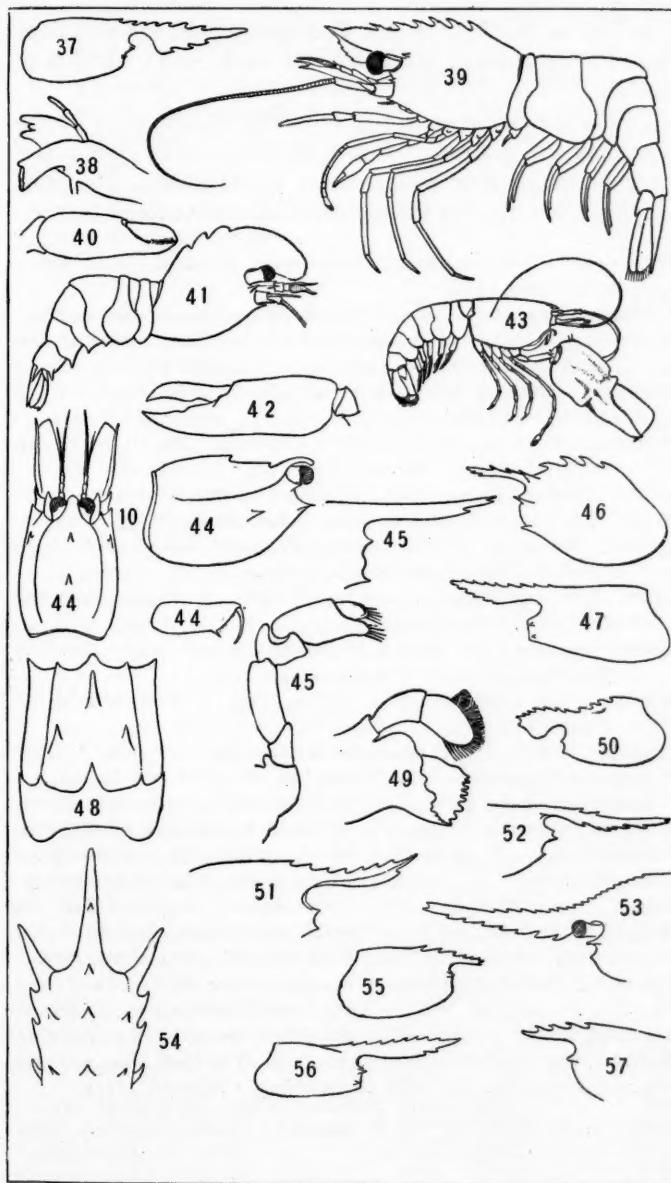
J. S. KINGSLEY.

IN the preparation of this number of the "keys" now being published in the *American Naturalist*, it has been the endeavor to include all the shrimps and prawns reported from the waters of North America north of the southern boundary of the United States and within the 100-fathom line. It is believed that this key will serve for the identification of any species (except in the genera Hippolyte and Pandanus) now known to inhabit our waters; but the student may reasonably expect that several tropical species may later be found within these limits. The genera most likely to furnish additions of this character are Alpheus, Palæmon, Peneus, Atya, and Caridina.

In using the synopsis which follows, the student must remember that the characters of the key are not repeated. It will be seen that the mandibles furnish important characters. With a little practice these structures may be readily removed with the dissecting needle without injuring the specimen for exhibition purposes. Caridea should only be preserved as alcoholic material; any attempt to dry them proves disastrous. The terminology of parts employed below, with few exceptions, will be understood by any one who has dissected a cray fish or lobster. Branchiostegal spines are small spines just below the antennæ, near the anterior margin of the carapax. The carpal joint is the antepenult segment of the legs and is spoken of as annulate, where it is broken up into a number of smaller joints (see Fig. 39).

The geographical distribution of the species is roughly indicated by full-face letters following the specific name. These letters are: **A**, Alaska south; **D**, Monterey to San Diego; **M**,





Cape Cod to North Carolina; **N**, Atlantic coast south to Cape Cod; **P**, Puget Sound to San Francisco; **S**, South Carolina to Florida.

The Caridea are aquatic decapod crustacea, commonly known as shrimps and prawns. Most of them are marine, but a few occur in the warmer fresh waters of the globe. The most important literature for the student of American forms follows:

SAY. Crustacea of the United States. *Journ. Acad. Nat. Sci.* Vol. i. Philadelphia, 1818.

H. MILNE-EDWARDS. Histoire Naturelle des Crustaces. Tome 2. 1837. STIMPSON. Crustacea and Echinoderms of Pacific Coast. *Journ. Boston Soc. Nat. Hist.* Vol. vi. 1857.

STIMPSON. Prodromus descr. animal. evert. [etc.]. *Proc. Acad. Nat. Sci.* Philadelphia, 1860.

STIMPSON. Notes on North American Crustacea. *Annals N. Y. Lyc. Nat. Hist.* Vol. x. 1871.

DANA. Crustacea United States Exploring Expedition. 1852.

OWEN. Crustacea in Beechey's Voyage to the Pacific. 1839.

KRÖYER. Monograf. Slægten Hippolyte's nord. Arter. *Vid. Selsk. Afhandl. Kjøbenhavn.* Bd. ix. 1842.

SMITH. Crustacea Atlantic Coast North of Cape Cod. *Trans. Connecticut Acad. Sci.* Vol. v. 1879.

SMITH. Crustacea in Invertebrate Animals of Vineyard Sound. *Rep. U. S. Fish Commission for 1871-72.* 1873.

KINGSLEY. On a Collection of Crustacea [etc.]. *Proc. Acad. Nat. Sci.* Philadelphia, 1879.

KINGSLEY. Carcinological Notes, No. v. *Bulletin Essex Inst.* Vol. xiv.

ORTMANN. Crangonidae. *Proc. Acad. Nat. Sci.* Philadelphia, 1895.

Less important are: STIMPSON: *Am. Journ. Sci.*, II, vol. xxix (Ft. Macon, N. C.).—STIMPSON: Invertebrata of Grand Menan, *Smithsonian Contributions*, 1853.—GIBBES: *Proc. Am. Assoc. Adv. Sci.*, vol. iii, 1851.—

BATE: (Puget Sound), *Proc. Zool. Soc. London*, 1864.—LOCKINGTON: *Proc. Cal. Acad. Nat. Sci.*, 1876.—LOCKINGTON: (Alpheus), *Ann. and Mag. Nat. Hist.*, vol. i, 1878.—KINGSLEY: (Alpheus), *Bull. U. S. Geol. Survey*, 1878.—KINGSLEY: *Proc. Acad. Nat. Sci.*, Philadelphia, 1878.—

KINGSLEY: *Bull. Essex Inst.*, vol. x.—ORTMANN: Atyidae, *Proc. Acad. Nat. Sci.*, Philadelphia, 1894.—HOLMES (California): *Proc. California Acad. Sci.*, II, vol. iv, 1894.—WALKER (Puget Sound): *Trans. Liverpool Biol. Soc.*, vol. xii, 1898.—BENEDICT: *Proc. U. S. Nat. Mus.*, vol. xviii, 1895.—SMITH: *Rep. U. S. Fish Commission for 1872-73.* 1874.

KEY TO THE GENERA OF CARIDEA.¹

1. Body usually cylindrical, elongate; antennæ long; abdomen large, usually extended, and bearing, as a rule, six pairs of feet (pleopoda), the sixth pair, together with the telson, forming a caudal fin MACRURA 2
1. Body depressed; antennæ small; abdomen small, and folded under the cephalothorax; no caudal fin formed BRACHYURA
2. Last pair of thoracic feet normal 3
2. Last pair of thoracic feet reduced and dorsal in position ANOMURA (pars)
3. Carapax with two longitudinal dorsal sutures; antennal scale small or lacking; cervical suture frequently present THALASSINIDEA.
3. Longitudinal sutures lacking; cervical frequently present; carapax united in front to epistome ASTACIDEA
3. Carapax not united to epistome, sutures lacking; antennal scale large CARIDEA 4
4. Not more than two pairs of feet chelate 5
4. Three anterior pairs of feet chelate PENEIDÆ 28
5. Mandibles slender, incurved, not expanded or bifid at the tip; no mandibular palpus (Fig. 11) CRANGONIDÆ 6
5. Mandibles stout, crown broad, dilated (Fig. 49) ATYIDÆ 14
5. Mandibles with the crown deeply bifid (Fig. 38) PALÆMONIDÆ 17
6. First pair of feet the stouter, subchelate (Fig. 1 a); i.e., the movable finger closing on the palm CRANGONINÆ 7
6. First pair of feet the stouter; chelate LYSMATINÆ 10
6. Second pair the larger GNATHOPHYLLINÆ (extralimital)
7. Second pair of feet chelate 8
7. Second pair of feet not chelate Sabinea 36
7. Second pair of feet obsolete, rostrum long Paracrangon 39
8. Branchiæ five on either side 9
8. Branchiæ seven on either side Pontophilus 37
9. Rostrum short, eyes free Crangon 29
9. Rostrum obsolete, eyes nearly concealed Nectocrangon 38
10. Rostrum long 11
10. Rostrum short, antennæ biflagellate Concordia 45
11. External maxillipeds with exopodite 12
11. External maxillipeds without exopodite Tozeuma 42
12. Carpus of second pair triannulate 13
12. Carpus of second pair multiarticulate Hippolyssmata 40
13. Carapax with a median dorsal spine Latreutes 43

¹ The *American Naturalist* will undertake to determine and return any specimens that cannot be placed in the keys, and solicits correction and criticism for future revision.

13. Carapax without median spine	<i>Rhynchocyclus</i> 44
14. Feet without exopodites; fresh water	<i>ATYINÆ</i> 15
14. Feet with exopodites; marine	<i>EPHYRINÆ</i> 16
15. Third pair of feet scarcely larger than the anterior pairs	<i>Caridina</i> 46
16. Rostrum toothed, three anterior pairs of feet slender	<i>Acanthephyra</i> 47
17. First pair of feet the larger, chelate	<i>ALPHEINÆ</i> 18
17. First and second pair of feet slender, the first not chelate	 (<i>PANDALINÆ</i>) <i>Pandalus</i> 65
17. Second pair of feet the larger, both pairs chelate	<i>PALÆMONINÆ</i> 24
18. Mandible with palpus	19
18. Mandible without palpus	23
19. Carpus of second pair annulate	20
19. Carpus of second pair not annulate	22
20. Rostrum very short or absent	21
20. Rostrum moderate or long	22
21. Eyestalks short, eyes hidden under carapax	<i>Alpheus</i> 48
21. Eyestalks long, eyes free	<i>Ogyris</i> 61
22. First pair of feet short, second slender	<i>Hippolyte</i> 59
22. First and second pairs of feet subequal	<i>Caridion</i> 60
23. Carpus of second pair triarticulate	<i>Virbius</i> 62
23. Carpus of second pair five-articulate	<i>Thor</i> 64
24. Mandibles without palpus	25
24. Mandibles with palpus; antennula triflagellate	<i>Palæmon</i> 72
25. Antennula biflagellate, one branch divided at the tip	26
25. Antennula triflagellate	27
26. Rostrum short; external maxillipeds broad	<i>Pontonia</i> 66
26. Rostrum long, slender; external maxillipeds slender	<i>Anchistia</i> 67
27. Rostrum toothed above only	<i>Urocaris</i> 71
27. Rostrum toothed above and below	<i>Palæmonetes</i> 68
28. Posterior pair of feet not annulate	<i>Peneus</i> 74
28. Posterior pair of feet annulate	<i>Sicyonia</i> 76

SYNOPSIS OF NORTH-AMERICAN CARIDEA.

Family CRANGONIDÆ. First and second pairs of feet unequal.

Sub-family CRANGONINÆ. External maxillipeds pediform.

G. *Crangon* Fabr. Eyes free; antennulae biflagellate; posterior feet acuminate.

29. Carapax strongly sculptured; at least two spines in the median line; abdomen usually sculptured	30
29. Carapax not strongly sculptured; one median and one lateral spine on either side	34
30. Median carina of carapax with three or four spines; abdomen longitudinally keeled	31
30. Median carina two-spined	32

31. Epimera of abdomen spined; carapax with more than three keels; rostrum simple *C. salebrosus* Owen **A**

31. Abdominal epimera without spines; carapax with three carinae, the middle one four-spined *C. sharpei* Ortmann **A**

21. Middle keel three-spined *C. boreas* (Phipps) Fabr. **A, N**, Fig. 2

32. Epimera without spinules; a median carina on abdomen, the sixth segment with two carinae *C. intermedius* Stm. **A**, Fig. 44

32. Epimera without spinules; abdomen not sculptured 33

33. Second lateral carina complete *C. munitus* Dana, Fig. 48

33. Second lateral carina extending half the length of the carapax
C. munitellus Walker **P**, Fig. 31

34. A spine on each side of the posterior margin of fifth abdominal segment; palm very oblique *C. franciscorum* Stm. **P, D**, Fig. 3

35. Fifth abdominal segment without spines
C. vulgaris Fabr. **A, D, P, N, M**, Fig. 1

G. *Sabinea* Owen. Rostrum very short; eyes free, stout; second pair of feet short; branchiae seven.

36. Rostrum obtusely rounded; telson subtruncate
S. septemcarinata Ross **N**, Fig. 4

36. Rostrum and telson acute *S. sarsi* Smith **N**, Fig. 5

G. *Pontophilus* Leach, Sars. Rostrum short, eyes free, second pair of feet very short.

37. Rostrum very short, tridentate *P. brevirostris* Smith **M**

37. Rostrum longer *P. norvegicus* Sars **N, M**

G. *Nectocrangon* Brandt. Dactyli of fourth and fifth pairs of feet dilated.

38. Two spines in the middle line of the carapax behind the rostrum
N. lar (Owen) Brandt **N, A**

38. Three spines behind rostrum *N. alaskensis* Kingsley **A**

G. *Paracrangon* Dana. Rostrum elongate, fourth and fifth pairs of feet acuminate.

39. *P. echinatus* Dana **P**, Fig. 54

Sub-family LYSMATINÆ. Carpus of second pair annulate; external maxillipeds pediform.

G. *Hippolytsma* Stimpson. Four anterior pairs of feet with exopodites; first pair stout, second slender.

40. Branchiostegal spine present 41

40. No branchiostegal spine *H. wurdeanni* (Gibbes) Stm. **M, S**, Fig. 6

41. Flagella of antennula nearly as long as body; antennal scale tapering
H. intermedia Kingsley **S**, Fig. 7

41. Flagella of antennula $1\frac{1}{2}$ times length of body; antennal scale broad
H. californica Stm. **D** Fig. 8

G. *Tozeuma* Stimpson. Body elongate, rostrum very long; external maxillipeds very short; carpus of third pair triarticulate.

42. *T. carolinensis* Kingsley **M, S**, Fig. 18

G. Latreutes Stimpson. First pair of feet with exopodites, carapax with a median spine.

43. *L. ensiferus* (M.-Edw.) Stm. Gulf weed

G. Rhynchocycclus Stimpson. Four anterior pairs of feet with exopodites, carpus of second triarticulate.

44. *R. parvulus* Stm. Texas

G. Concordia Kingsley. Rostrum very short; carpus of second pair triarticulate.

45. *C. gibberosa* Kingsley **M**, Fig. 17

Family ATYIDÆ. First two pairs of feet nearly equal, carpus of second pair not annulate.

Sub-family ATYINÆ.

G. Caridina Milne-Edwards. Rostrum prominent; carpus of first pair very short.

46. *C. pasadenæ* Kingsley, southern California Fig. 45

Sub-family EPHYRINÆ.

G. Acanthephryra. Rostrum toothed; antennulæ biflagellate.

47. *A. pacifica* (Holmes) Fig. 52

Family PALÆMONIDÆ.

Sub-family ALPHEINÆ. Second pair of feet usually chelate; carpus frequently annulate.

G. Alpheus Fabricius. First pair of feet usually very unequal; carpus of second annulate.

48. Rostrum present; orbital hoods prolonged into spines 49

48. Rostrum spiniform; orbital hoods not spined 55

48. Rostrum absent; orbital hoods not spined 57

49. Dactylus of larger pincer normal 50

49. Dactylus of larger pincer horizontal or inverted 54

50. Larger hand with both margins entire 51

50. Larger hand with margins constricted above and below 52

51. Feet of posterior pairs not spined beneath . *A. biunguiculatus* Stm. (*læviusculus* Lockington. Originally descended from Hawaiian Islands; may occur on west coast of United States).

51. Posterior feet spined below *A. minus* Say **M, S, D**

52. A spine on basal joint of antenna 53

52. No spine on basal joint of antenna *A. websteri* Kingsley **S**, Fig. 13

53. Dactylus of smaller hand with straight lower margin

A. bellimanus Lockington **D**

53. Dactylus of smaller hand with tooth near base

*A. equidactylus*¹ Lockington **D**

54. No spine on basal joint of antenna . . . *A. barbara* Lockington **D**

54. Basal joint of antenna spined . . . *A. clamator* Lockington **D**

55. Basal joint of antenna spined, larger hand constricted above and below

A. packardii Kingsley **S**, Fig. 9

¹ Imperfectly known; larger hand lost.

55. Basal joint without external spine; dactylus normal 56
 56. Upper margin of large hand notched, lower entire

A. floridanus Kingsley S, Fig. 42

56. Larger hand constricted above and below

A. heterochelis Say M, S, west coast Fig. 43

57. Dactylus working horizontally *A. candei* Guerin S, D, Fig. 36

57. Dactylus completely inverted 58

58. Hands of first pair equal *A. longidactylus* Kingsley D

58. First pair of hands unequal *A. harfordi* Kingsley D, Fig. 12

G. Hippolyte Leach. Rostrum not joined to carapax; external maxillipedes slender; first pair of feet short, equal. *Hippolyte* contains a large number of species, mostly from the colder seas. It is impossible to frame a key to the North American species at the present time. The following list includes the species found in our limits.

59. *H. affinis* Owen D, Fig. 15.
H. brevirostris Dana P, Fig. 57.
H. californiensis Holmes, Fig. 16.
H. cristata Stm. P.
H. esquimaltiana Bate P.
H. fabricii Kröyer N, Fig. 29.
H. gaimardii M.-Edw. N, P, Fig. 28.
H. gracilis Stm. P.
H. grænlandica (Fabr.) Miers. N, A, P.
H. hemphilli Lockington, California.
H. hermanni (Walker) P, Fig. 21.
H. incerta Buchholz N.
H. lamellicornis Dana P, Fig. 50.

H. layi Owen D, Fig. 14.
H. macilenta Kröyer N, Fig. 33.
H. microceros Kr. N, Fig. 25.
H. palpator Owen D, Fig. 55.
H. panschii Buchholz N.
H. phippsii Kröyer N, A, P, Figs. 19, 24.
H. picta Stm. D.
H. polaris (Sabine) Owen N, Figs. 23, 26.
H. prionota Stm. P, Fig. 41.
H. pusiola Kr. N, M, Fig. 22.
H. securifrons Norman N, Fig. 39.
H. sitchensis Brandt A.
H. spinus (Sowerby) White N, A, P, Figs. 32, 46.
H. stylus Stm. P.
H. suckleyi Stm. P.
H. taylori Stm. D.

G. Caridion Goës. Rostrum elongate, three-jointed mandibular palpus, carpus of second pair obsoletely biarticulate.

60. *C. gordoni* (Bate) Goës N, Fig. 51

G. Ogyris Stm. Rostrum very short, mandibular palpus two-jointed; carpus of second pair triarticulate.

61. *O. alpherostris* Kingsley M, Fig. 35

G. Virbius Stm. Antennulae biflagellate; carpus of second pair triarticulate.

62. No hepatic spine; antennal scale moderate.

V. acuminatus (Dana) Stm. Gulf weed

62. Hepatic spine present 63

63. Antennal scale moderate, rostrum elongate *V. zostericola* Smith **M**, Fig. 30

63. Antennal scale as long as carapax; rostrum half as long as carapax *V. pleuracanthus* Stm. **M, S**

G. Thor Kingsley. Carpus of second pair five-articulate.

64. *T. floridanus* Kingsley **S**, Fig. 20

 Sub-family PANDALINÆ. Carpus of second pair multiarticulate.

G. Pandalus Leach. It is at present impossible to frame a key for the species.

65. *P. borealis* Kr. **A, N.** *P. hypsinotus* Brandt **A.**
P. danaæ Stm. **P**, Fig. 27. *P. leptoceros* Smith **N, M.**
P. dapifer Murdoch **A.** *P. montagui* Leach **N, M.**
P. franciscorum Kingsley **P.** *P. platyceros* Brandt **A.**
P. gurneyi Stm. **D.** *P. pubescens* Dana **P**, Fig. 53.

 Sub-family PALÆMONINÆ. Carpus of second pair never annulate, feet without exopodites.

G. Pontonia Latreille. Rostrum short, external maxillipeds expanded, with exopodites.

66. Carapax smooth; dactylus of larger hand of second pair with two teeth *P. domestica* Gibbes **S**

66. Carapax pubescent; dactylus of larger hand with one tooth *P. unidens* Kingsley **S**, Fig. 40

G. Anchistia Dana. Rostrum long, slender; second pair of feet slender, equal.

67. *A. americana* Kingsley **S**, Fig. 10

G. Palæmonetes Heller. Rostrum long lamellate; antennal and branchiostegal spines present; fresh or brackish water.

68. Fresh-water species 69

68. Salt or brackish water species 70

69. Rostrum without teeth below *P. antrorum* Benedict. Well in Texas

69. Rostrum toothed below. *P. paludosa* (Gibbes) Kingsley, South Carolina, Great Lakes, Fig. 56.

70. Rostrum straight *P. vulgaris* (Say) Stm. **N, M, S**, Fig. 47

70. Rostrum recurved *P. carolinus* Stm. **M, S**

G. Urocaris Stimpson. Rostrum toothed above, toothless below; eyes elongate; sixth segment of abdomen very long.

71. *U. longicaudatus* Stm. **M, S**

G. Palæmon Fabricius. Rostrum lamellate; eyes free; mandibular palpus three-jointed.

72. Hepatic spine lacking, marine (S. G. Leander) 73

72. Hepatic spine present, fresh-water

P. ohionis Smith, Ohio and Mississippi rivers

73. Rostrum with 10 to 12 teeth above, 6 or 7 below

P. tenuicomis Say. Gulf weed, Atlantic

73. Rostrum with 7 to 8 teeth above, 3 below *P. ritteri* Holmes **D**, Fig. 37
 Family PENEIDÆ. Third pair of feet the largest.

G. *Peneus* Labreille. Rostrum elongate, external maxillipeds with exopodites.

74. Both flagella of antennæ very short; carapax sulcate near middle line *P. brasiliensis* Latr. **M, S, D¹**

74. Antennular flagella longer, no sulci near middle line 75

75. Carapax without median carina, rostrum entire below

P. constrictus Stm. **M, S**

75. Carapax carinate to nearly posterior margin; rostrum dentate below
P. setiferus (L.) M.-Edw. **M, S**

G. *Sicyonia* Milne-Edwards. Rostrum short; carapax carinate; external maxillipeds without exopodite.

76. Two teeth on median carina and two minute teeth on the rostrum
S. carinata (Oliv.) M.-Edw. **S**

76. Three teeth on median carina and four on the rostrum

S. brevirostris Stm. **S**

76. Three teeth on median carina, two on rostrum, the tip spined

S. laevigata

76. Two teeth on median carina, three on rostrum *S. dorsalis* Kingsley **S**

¹ Possibly the specimens of *P. canaliculatus* of Holmes belong here.

LIST OF FIGURES.

1. *Crangon vulgaris.*
2. *Crangon boreas.*
3. *Crangon franciscorum.*
4. *Sabinea septemcarinata.*
5. *Sabinea sarsi.*
6. *Hippolysmata wurdemanni.*
7. *Hippolysmata intermedia.*
8. *Hippolysmata californica.*
9. *Alpheus packardii.*
10. *Anchistia americana.*
11. *Hippolysmata californica*, mandible.
12. *Alpheus harfordi.*
13. *Alpheus websteri.*
14. *Hippolyte layi.*
15. *Hippolyte affinis.*
16. *Hippolyte californiensis.*
17. *Concordia gibberosa.*
18. *Tozeuma carolinensis.*
19. *Hippolyte phippsii (turgida).*
20. *Thor floridanus.*
21. *Hippolyte hermanni.*
22. *Hippolyte pusiola.*
23. *Hippolyte polaris.*
24. *Hippolyte phippsii.*
25. *Hippolyte microceros.*
26. *Hippolyte polaris (borealis).*
27. *Pandalus danae.*
28. *Hippolyte gaimardii (gibba).*
29. *Hippolyte fabricii.*
30. *Virbius zostericola.*
31. *Crangon munitellus.*
32. *Hippolyte spinus.*
33. *Hippolyte macilenta.*
34. *Hippolyte gaimardii.*
35. *Ogyris alpherostris.*
36. *Alpheus candei.*
37. *Palæmon ritteri.*
38. *Palæmon ritteri*, mandible.
39. *Hippolyte securifrons.*
40. *Pontonia unidens.*
41. *Hippolyte prionota.*
42. *Alpheus floridanus.*
43. *Alpheus heterochelis.*
44. *Crangon intermedius.*
45. *Caridina pasadenæ.*
46. *Hippolyte spinus.*
47. *Palæmonetes vulgaris.*
48. *Crangon munitus.*
49. *Caridina pasadenæ*, mandible.
50. *Hippolyte lamellicornis.*
51. *Caridion gordoni.*
52. *Acanthephyra pacifica.*
53. *Pandalus pubescentulus.*
54. *Paracrangon echinatus.*
55. *Hippolyte palpator.*
56. *Palæmonetes paludosa.*
57. *Hippolyte brevirostris.*

THE LIFE HABITS OF POLYPTERUS.

N. R. HARRINGTON.

a. *Living (Resting)*, b. *Feeding*; c. *Swimming*; d. *Breathing*; e. *Reproduction*.

REFERENCE has already been made to the occurrence of *Polypterus* in the Lower Nile (*Science*, Vol. V, 1898, Oct. 23, p. 54, and 1899, March 3, p. 315). The purpose of the present paper is to give a number of additional notes as to the occurrence and habits of this interesting and little-known fish. These details are treated in the following order:

Polypterus bichir differs but little in its habits from the other fresh-water fishes of the Nile. It lives in the deeper depressions of the muddy river bed, but it is an active swimmer and not essentially a bottom-liver or a mudfish. It is most active at night time when it is in search of its food.

Feeding.—Trawl lines were largely used as a means of collecting. They were laid late in the afternoon and left set all night. In the early morning, by three or four o'clock, besides many other large fish, a few *Polypteri* would usually be taken. Sometimes, however, specimens would be taken during the early morning in the second going-over of the trawls. Aside from small siluroids, *Armoot*, *Bayad*, *Schilbe*, *Schal*, which were commonly used as bait, *Polypterus* eats a great many other teleosts, as is evidenced by the more or less undigested remains in the stomachal pouch of such forms as *Cyprinodon*, *Anguilla*, and *Chromis*. It apparently catches them alive, for it prefers live bait and always swallows its food whole. Although catfish are usually taken head first, some fish were found in the stomachal pouch in a reverse position; their undigested remains are probably ejected through the mouth. The pouch is admirably adapted for resisting the very dangerous and strong spines possessed by all the catfishes.

On account of the great vitality of the siluroids they probably remain alive for some time after they are taken into the digestive

tracts ; but their strong pectoral and dorsal spines, which close backward against the body, are kept from doing any harm by the strong muscles of this gastric pouch, which compress the enclosed fish and prevent the erection of its spines.

Swimming.—Peculiar in the swimming movements of *Polypterus* is the manner in which the head moves freely from side. This produces the appearance of a progression more or less snake or eel-like, although in general the powerful sweeps of the strong tail characterize the progression as fish-like.

The pectoral fins were never observed to be used otherwise than are the pectoral fins of most other fishes, *i.e.*, primarily as balancing organs, but partly as organs of progression. There is no evidence that *Polypterus* uses its fins in the manner figured by Klaatsch in *Gegenbaur's Festschrift* (Vol. III) as organs for walking or crawling. The spreading cartilaginous pectoral fin rays give a mobility to the pectorals which is strikingly and beautifully displayed in a high development of the "trembling movement," so often seen in the balancing fins of teleosts.

The long dorsal fin is not always erect when the animal is swimming. It can be raised or lowered at will.

Breathing.—In spite of repeated observations, there is little positive evidence that *Polypterus* comes often to the surface to breathe. The evidence which can be presented concerns a number of fish, which were confined in a large wicker basket partially immersed in the river. In swimming around the narrow limits of this cage the *Polypterus* would stick its head out of water, but no more than would any fish similarly confined. On one occasion, while fishing a few miles above Damietta, we saw a *Polypterus*, about forty feet from us, thrust the anterior end of its body six inches out of the water, make two or three gasps, and then swim slowly away. But this fish, like many others found in the locality, was dying from the increased salinity of the water at this point, caused by the unusually low Nile and the backing up of the Mediterranean at high tide.

Although the fish was not often seen taking in air, the following fact goes to show that a respiratory function is possessed by the swimming bladders or lungs. When the fish is opened alive, a marked peristalsis may be observed making its way

along the right (larger) lobe of the so-called lungs. These structures open by the common large (about 2 cm. long) glottis into the pharynx, and they contain normally about four or five hundred cubic centimeters of air. A further discussion of the respiratory function of these bladders will be given later, when their histology can be discussed ; but their principal resemblance to amphibian or reptilian lungs is shown in the relations of the capillaries and the arrangement of the blood vessels running to and draining them.

REPRODUCTION.

1. Migration. 2. Time and place of breeding. Manner of fertilization — size and character of eggs. 3. List of fish as to ovaries.

1. *Migration.*—Several of the fresh-water fishes found in the Nile migrate each season to the Mediterranean to spawn. This is the case with the eel (Hanash) and the several species of mullets. It has never been supposed that *Polypterus* could be found in any considerable numbers north of the second cataract, so that there seemed to be little likelihood that this fish migrated. When, however, fish were found in this lower part of the river more abundantly than in any other part known, except the head waters, it became a possibility that *Polypterus* had migratory habits. Investigation of the distribution of *Polypterus* at points intermediate to the second cataract and the mouth showed that in the large brackish Lake Menzaleh, an enlargement of the Delta, no adult fish could be got, although it was reported that two young *Polypteri* were obtained here the year before. The single specimen in the Natural History Museum at Cairo was the only one which had been seen in the local markets there for a number of years. At Assiout, 325 miles from the sea, the fishermen did not recognize the stuffed specimen shown them, but when the name, "aboubichir," was mentioned they said that such a fish was occasionally found there ; that it came from bad crocodiles' eggs and went down the river, while the good eggs brought forth young crocodiles that went up river !

The preceding facts as to distribution indicate that the fish does not pass by these several stations below the second cataract. It is, therefore, probable that the very considerable number of fish, which were taken over a limited territory, only a few miles in extent, were not individuals who were migrating, but fish that were living the year round in this locality. They were, in the full sense of the terms, healthy normal fish, and seemed to frequent certain holes, where they could repeatedly be taken with a circular throw-net. The males are smaller than the females, and although they are much less numerous, are generally taken in company with one or more females.

Aside from the lack of evidence as to *Polypterus* being a migratory fish that can be deduced from the facts of distribution, the continuance of mature individuals at Mansourah for a period of three months cannot be explained on the migration hypothesis. But the principal fact bearing against the latter view is that the adult fish is so affected by salt water that a slight increase in salinity kills it. On June 10, at Inanieh, a point four miles from Damietta, we came upon a number of dead *Polypteri* thrown up on the bank. The water was slightly brackish, and the fish evidently had been killed by some such particular cause. No other kinds of fish were found dead. The salt water, which had reached this point owing to the low Nile, continued to back up the river, until seven weeks later, August 2, it had reached Toela, some thirty miles from the sea. Being then stationed at Mansourah, a number of fish were brought in to us, which for the first time during our stay here were not fresh. Rigorous cross-questioning brought out the fact that they had been picked up dead upon the river bank at this town, Toela, which was now dependent on the canals for drinking water and irrigation, the Nile there being brackish. Several of the fish which had been killed by the salt water were heavily laden with eggs.

The chief reasons, therefore, for believing that *Polypterus* is not a migratory fish are : (1) It is unrecorded, in any numbers, at points intermediate between Mansourah and the second cataract; (2) females remain at Mansourah for several months longer than the actual time required for spawning; (3) the

mature fish do not survive salt water long enough even to shed their ova.

2. *Place and Time of Breeding.*—If the specimens taken at Mansourah are not migrating, where and when does *Polypterus* breed? Probably at any point on the river where the adult fish may be found in numbers. Such regions are presumably to be found about the head waters of the Nile, and it is possible, further, that, like some other river fishes, they prefer the small brooks or springs for spawning. There seems to be no reason, however, why the few fish, which are found heavily laden with eggs at Mansourah, should not spawn in this vicinity, *i.e.*, below the first cataract; for it is practically impossible for them to pass the barrage. Besides the individuals taken with eggs, others were observed, the ovaries of which retained only here and there a few large ova still attached, the remainder having evidently been cast out.

The time of the breeding of *Polypterus* can be approximately determined not only by the gradual ripening of the eggs from June to September, but since the spawning seasons of nearly all Nile fishes correspond in a rough way, there is evidence that *Polypterus* probably breeds during or just after the inundation of the Nile. *Cyprinodon*, which brings forth its young alive, was one of the earliest fish to spawn, and its eggs had all disappeared before the middle of July. Between this time and the first of September, *Schal*, *Schilbe*, *Bayard*, and *Armoot*, in the order named, laid their eggs. The latter spawned latest, and its eggs during the summer seemed to keep pace in ripening with those of *Polypterus*.

Copulatory Organ.—The anal fin of the male *Polypterus*, which has already been described as being somewhat larger than that of the female, is undoubtedly a copulatory organ. When the fish is alive, this fin, if blown upon or irritated, assumes a hollow and pointed spoon-shaped appearance.

List of Fish Taken.—There follows a partial list of the fish taken during the summer, with occasional reference to the condition of the reproductive organs.

June 10. 7-8 bichir, principally dead females which carried large numbers of ova.

June 14. Two living bichir from Ras-el-Ghelig. Females with eggs.

June 15-20. Several dead brought in from banks of Nile

June 22. Two from market at Mansourah.

June 25. Two.

June 27. One.

July 2. Two males and two females. A promising but unsuccessful trial to rear larvæ was obtained from this material by means of artificial fertilization, the females bearing well-advanced eggs (which could not, however, be readily shaken from the ovarian stalk), and the sperm being fairly active.

July 3. One male with immature sperm.

July 4. Two females, both with eggs.

July 5. One male, two females.

July 6. Three females, one of whom had shot eggs.

July 7. Three females, all with eggs.

July 8. One female.

July 9. One female with eggs.

July 10. Three females, two large specimens with eggs, one small without.

July 11. Three females, two large with eggs, one small without.

July 13. One large female with eggs.

July 14. One large female with eggs, one small without.

July 15. Two large females with eggs.

July 16. One large and one small female, both with eggs.

July 17. One large female with eggs.

July 18. Two large females with eggs.

July 20. One female.

July 21. One small male, one large female with eggs.

July 22. Two females.

July 25. One small male, one female with eggs.

July 26. One small male and two large females, both with eggs.

July 27. Five females, all with eggs; one small male.

Aug. 1. One very large male (rather smaller than average large female).

Aug. 2. Two large females, one had shot eggs.

Aug. 3. Three fish from Toela (salt water), one male, two females.

Aug. 4. One small male, one large male, one female which had shot her eggs.

Aug. 5. Five females, three with eggs, two had shot eggs ; all below average size.

Aug. 8. A pretty pair, male and female, apparently caught in same net. Female without eggs, male with striking copulatory anal fin.

Aug. 9. Three not designated.

Aug. 10. Two not designated.

Aug. 15. One not designated.

Aug. 21. Two, both females full of eggs.

Aug. 24. One large female with eggs.

Aug. 25. One.

Sept. 1. Female at Damietta with eggs.

A review of the above list shows plainly that the greatest difficulty we found in getting the developmental stages at Mansourah by artificial fertilization was the scarcity of mature males. There were only twelve males to fifty-eight females. Although sexually mature individuals of both sexes will be seen to have been brought in the same day, it was found exceedingly difficult to keep one promising specimen alive and healthy until an equally promising mate could be secured. As many as fifteen fruitless attempts were made to raise larvae, by mixing sperm that moved actively with eggs which appeared ripe (although these could never be shaken from the ovarian stalks in large numbers).

This practical difficulty in keeping *Polypterus* in confinement is due to the fact that it is not an especially hardy fish. It will not survive more than three or four hours out of water, and only then under the most favorable conditions ; that is, covered with damp grass and weeds. The Nile catfishes *Clarias* and *Bagrus*, on the other hand, retain an unimpaired vitality after twice as long an exposure to similar conditions. It is well known that these catfishes have accessory branchial organs, and some species make considerable journeys overland. Physiologically at least, therefore, *Polypterus* has not evolved

very far toward a land-living or even an air-breathing type, although morphologically, *i.e.*, especially in its organs of respiration and circulation, it certainly presents the essential characters of the lower amphibia. They are feebly developed in some respects, but nevertheless include all the morphological and physiological potentialities of a higher vertebrate. On the other hand, in the possession of spiracles and in primitive skeletal characters, it strongly resembles the oldest fishes (Elasmobranchii). Several writers have recently contributed very convincing evidence that crossopterygians were lineal ancestors of the higher vertebrates, but judging from the conditions in *Polypterus* they were also sufficiently remote in the phylum of vertebrates to have given rise to both dipnoans and amphibians.

DEPARTMENT OF ZOOLOGY,
COLUMBIA UNIVERSITY,
May 12, 1899.

PADS ON THE PALM AND SOLE OF THE HUMAN FœTUS.

ROSWELL H. JOHNSON.

IN examining the soles of the feet of human fœtuses of two and three months, I have found four distinct dome-like elevations situated interdigitally along the line of the metatarso-phalangeal joints. Similar mounds were found in the corresponding position upon the palm, there being, however, only three true mounds in a transverse line. The thumb-index finger elevation was merely represented by the large thenar eminence. The reason for the absence of the true mound is probably that its presence would interfere with the opposition of the thumb. Upon the palm the mounds are less distinct, and in the older fœtuses the well-defined outline becomes lost, leaving only an elevation comparable to the "mounts" of the palmists, to which Wilder (97) has called attention. The mounds on the sole are succeeded by the smooth "ball" of the foot of the adult in embryos of about one hundred millimeters in length.

Unfortunately the poor preservation of many of the specimens resulting from the inevitable exigencies of their collection and preservation make it impossible to determine precisely the stage of development attained by the pads in the various cases. This difficulty and the gradual increase to a maximum with the subsequent gradual decrease prevent a precise statement of the stages of development of the fœtus where the pads are evident. The accompanying table shows the conditions found in the embryos examined, with the exception of a few cases of very



FIG. 1. — Plantar surface of the right foot of fœtus, No. 259 Minot collection. The method of stippling causes the mounds to appear with too sharp outlines.

bad preservation. It is believed by the author that the variation shown is the result of the preservation and not a real individual variation. This cannot be definitely stated however.

NO. IN COLLEC- TION.	COLLECTION.	LENGTH IN MM.	CONDITION OF PADS ON FEET.	CONDITION OF PADS ON HANDS.
67	H. M. C.	31	Slightly developed.	
58	P. & S.	36	"	Slightly developed.
2	P. & S.	42	Well developed.	Well developed.
32	"	44	"	"
21	"	55	"	Fairly developed.
249	H. M. C.	57	"	"Mounts" barely shown.
	N. Y. L. I. H.	65	"	
183	H. M. C.	69	Fairly developed.	Fairly developed on one hand.
6	P. & S.	70	Slightly developed.	Not present as pads.
110	H. M. C.	76	"	"
20	P. & S.	80	Well developed.	Fairly developed.
149	H. M. C.	85	Fairly developed.	Not present as pads.
30	P. & S.	97	Not present.	"
8	"	100	Poorly developed.	Faintly developed.
3	H. M. C.	103	Not present.	Not present as pads.
216	"	104	"	"
51	P. & S.	105	Scarcely discernible.	"
10	"	115	Not present.	"
12	"	120	"	"
68	H. M. C.	120	Scarcely discernible.	"
239	"	150	"	"

H. M. C.=Harvard Medical School Collection.

P. & S.=Collection of College of Physicians and Surgeons, Columbia Univ.
N. Y. L. I. H.= " " New York Lying-in Hospital.

Sections (Figs. 2 and 3) show the pad to be the result of the growth of the mesodermic tissue beneath, rather than an epidermic thickening. A cross-section (Fig. 4) of the right hind foot of a cat embryo in the region of the Anlagen of the walking pads shows an essential similarity in their form, position, and structure with the mounds on the human foetal foot (Fig. 2).

Since the interdigital position precludes the possibility of the mounds being merely contour lines resulting from the influence of the joints or digits, we may infer from the fact that the position is characteristic of walking pads that we have here structures of this kind. Further evidence lies in the fact that

in the baboons we have in the same positions upon the palm and sole strongly developed mounds with marked patterns of the epidermic ridges, and that in man there are upon the palms

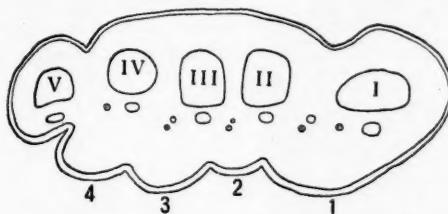


FIG. 2.—Cross-section of the left foot of the same fetus. Section 193 G 48 in collection of slides in Harvard Medical School. Roman numerals = metatarsal bones. Arabic numerals = number of mound.

and soles "patterns" (Galton) or "centers of disturbance" (Wilder) of the epidermic ridges at these points. Seldom, however, do we find them all present upon one palm or sole.

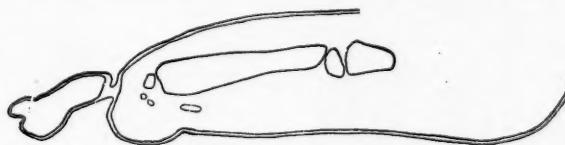


FIG. 3.—Longitudinal section of the right foot of the same fetus. Section 194 H 20 in Harvard collection.

Typically there is but one pattern upon the adult hand and two upon the adult foot. The accompanying table shows the relative frequency of occurrences of the several patterns in the adult.

	NUMBER OF THENAR PATTERNS.	NUMBER OF RA- DIAL OR TIBIAL PATTERNS.	NUMBER OF MEDIAN PATTERNS.	NUMBER OF FIBU- LAR OR ULNAR PATTERNS.
200 hands. 41 feet.	17 = 8.5 % 39 = 95.1 %	13 = 6.5 % 9 = 21.9 %	129 = 64.5 % 32 = 78.1 %	62 = 32.5 % 5 = 12.1 %

It will be noticed that with the exception of the ulnar-fibular pattern the occurrence of any pattern is more frequent in the

case of the feet than in the case of the hands, as might be expected from the poorer development of the mounds upon the foetal palm.

The ulnar-fibular pattern is remarkable not only for the fact that it is the only one of the four metatarso-phalangeal patterns which occurs less frequently in the feet than in the hands, but also for the fact that of these four "centers" it is the only one which occurs more frequently in the female than the male, as the following table shows.

	CASES IN 100 MALE HANDS.	CASES IN 100 FEMALE HANDS.
Thenar	12	5
Radial-tibial	9	4
Median	75	54
Ulnar-fibular	25	40
Hypothenar ¹	29	37

I am under great obligations to Dr. C. B. Davenport, for suggestions and criticisms; to Professor C. Sedgwick Minot, for kindness in allowing me to examine his collection of foetuses

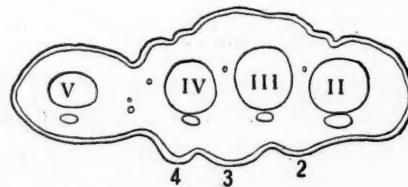


FIG. 4. — Cross-section of the right hind foot of a cat foetus in region of the Anlage of the walking pad. Section 195 B 100 in Harvard collection. Roman numerals = metatarsal bones. Arabic numerals = number of mound.

and to section the feet figured, and for suggestions and criticism; to Professor H. H. Wilder, for the use of a series of footprints; and to Dr. J. A. Blake, for permission to examine the collection of foetuses of Columbia University.

¹ The hypothenar pattern is one not in the metatarso-phalangeal series. See Figs. 5 and 6.

CONCLUSIONS.

I. There are upon the sole of the human fœtus of two to three months four mounds situated interdigitally along the line of the metatarso-phalangeal joints. Three mounds exist in a similar situation upon the palm of the fœtus of the same age. In the foot the mounds disappear. Upon the hand they persist as the less definite "mounts" of palmistry.

II. These mounds are homologous with the walking pads of some mammals, and have a direct relation to the "centers of



FIG. 5.—Palm of a fœtus of *Eotomys gapperi*.



FIG. 6.—Palm of Inuus (from Kollmann after Purkinje).

disturbance" of the epidermic ridges upon the palms and soles of man and other primates.

III. Corresponding with a poorer development of these mounds upon the hand than on the foot in the fœtus, the "centers of disturbance" occur upon the foot more frequently than upon the hand in the adult.

HARVARD UNIVERSITY,
May 23, 1899.

BIBLIOGRAPHY.

ALIX, M. Recherches sur la disposition des lignes papillaires de la main et du pied. *Ann. des Sci. Nat.* Tome viii, 1867, pp. 295-362, et Tome ix, 1868, pp. 5-42, avec Pls. 2-5.

GALTON, FRANCIS. Finger Prints. London, 1892.

KLAATSCH, H. Zur Morphologie der Tastballen der Säugethiere. *Morph. Jahrb.* Bd. xiv, pp. 407-435, Tomes xvii and xviii, 1888.

KOLLMANN, ARTHUR. Der Tastapparat der Hand der menschlichen Rassen und der Affen in seiner Entwicklung und Gliederung. Hamburg and Leipzig. Tomes i and ii, pp. 1-75, 1883.

PURKINJE. Commentatio de examine physiologico organi visus et systematis cutanei. Vratislav, 1823.

WILDER, H. H. On the Disposition of the Epidermic Folds upon the Palms and Soles of the Primates. *Anat. Anz.* Bd. xiii, pp. 250-256, 1897.

EDITORIAL COMMENT.

"New Species."—In a recent number of *Science* (No. 233) Mr. C. L. Marlatt speaks a necessary word as to some recent literature dealing with scale insects, pointing out that new species are being described upon entirely insufficient grounds. Every word of his short article is true; and, what is more, it is true in other fields than the Coccidæ. Every week brings to our table descriptive literature in which "new species" are founded upon the most trivial characters and new genera upon features of minor importance.

Mesenchyme vs. Mesenchyma.—There seems to be a growing tendency among writers on embryological matters to employ the word *mesenchyme* to denote the indifferent tissue of the middle germ layer. The word is taken from the German *mesenchym*, but pronounced as if it were *mesenkeim* in German. Why not use *mesenchyma*? It has good usage. It is not a foreign hybrid, and it belongs to a series of words that has been long in use, in botanical literature at least. We already have *collenchyma*, *kenenchyma*, *parenchyma*, *prosenchyma*, and *sclerenchyma*—why not *mesenchyma*?

Shade Trees.—One of the most crying needs of our larger cities is a concerted and intelligent popular movement for the planting and preservation of street trees. No one in the United States has done more to stimulate such action than William R. Smith, and the Massachusetts Horticultural Society has done well to publish in its *Transactions* for 1898 a lecture on the subject, delivered by him before the society in February, 1898.

"Easy Science."—*The Great Round World*, an excellent little juvenile newspaper, tells the children that a Siberian traveler has found a beautiful flower that blossoms in January, resembles the *Convolvulus*, a blossom lasting only a day, and on the third or fourth day has the ends of the fine anthers tipped with glistening diamond-like specks—the seeds. And this is called "Easy Science."

REVIEWS OF RECENT LITERATURE.

GENERAL BIOLOGY.

Rôle of Vexillary Organs. — To determine whether certain showy, so-called "vexillary" organs, external to the flower, have any part in attracting insects is the purpose of a series of careful observations by the veteran student M. Félix Plateau.¹ Two species are studied under prearranged conditions. One of them is *Salvia horminum*, whose strict stems are crowned with showy reddish or violaceous bracts, occupying the upper fourth of its height, with the small and inconspicuous flowers arranged in verticils, with green bracts lower on the stem. The question was: Would these showy tops, often mistaken by men for flowers, deceive the insects?

The insect visitors were mainly (more than 90 per cent) Hymenoptera, with a few Lepidoptera and Diptera. The bees, to which fertilization is mainly due, behaved as if the showy tops did not exist, passing directly to the flowers, and very rarely seeming to notice the "vexillary" parts. They behaved with the showy plants precisely as they did with other plants from which the showy tops had been removed, and just as they do with the wild germander (*Teucrium*), which has green tops.

The number and nature of the errors committed by insect visitors are tabulated in detail. These are mainly short haltings before the bracts without settling on them, and occur oftenest during passage from stem to stem and not on first approach. Including such slight mistakes, the Hymenoptera averaged but one error to fifty-five flowers visited; the Lepidoptera, one error to seven flowers visited. In case of the Lepidoptera (and Diptera also) the errors are oftener real errors, reaching even attempts at extracting nectar from the buds of showy bracts. These results add cumulative testimony to the acuter perceptions of the Hymenoptera.

Hydrangea opuloides was also studied; both the wild form, with a few showy, sterile, peripheral flowers to each of its cymes, and the

¹ Plateau, Félix. Nouvelles Recherches sur les Rapports entre les Insectes et les Fleurs; Étude sur le Rôle de Quelques Organes Dits Vexillaires, *Mém. Soc. Zool. de France*. Année 1898, pp. 339-375; 3 figs.

cultivated form (Japan rose), with flowers all sterile and showy. On the former the insect visitors were not numerous, and were limited to pollen-eating Diptera and Hymenoptera. These alight from the first upon the fertile flowers, passing directly over the sterile ones, making few even slight errors (Hymenoptera, one to seventy-seven visits ; Diptera, one to eighteen visits), making still fewer obviously complete mistakes. In the cultivated form the flowers are neglected altogether, or, retaining somewhere occasional anthers, attract a few *Syrphus* flies directly to these.

Having shown that the "vexillary" peripheral flowers are almost entirely disregarded by insects near at hand, M. Plateau proceeds to show that they do not exercise any special attraction at a distance, citing two facts in evidence : (1) that the peripheral flowers open several days before the fertile, and remain fresh for several days after the fertile have faded ; and (2) that the very showy cultivated flowers, lacking pollen and perfume, attract no insects. He shows also that insects do not learn by individual experimentation the nature of the two sorts of flowers. Then he objects to the idea of their possessing hereditary instinctive knowledge on the very insufficient ground of analogy with birds which have to learn to recognize inedible larvæ by individual experience.

The search for a basis in observable facts for the theories of coloration long current is certainly most desirable ; and while every one will acknowledge the value of the facts discovered, one may still think that they do not fully justify the general conclusion, that these so-called "vexillary" organs have no right to be so considered. For if one fully agree with M. Plateau, that the fertilization of the flowers in question "would not suffer from the absence of these parts" at the present time, still the old theory would serve to explain their origin in the past ; and the fact that mistakes are still made is not to be disregarded.

The old explanation of the coloration of bracts, etc., has been so satisfactory and so applicable to many facts of different kinds, that in absence of any substitute one may feel reluctant to abandon it, especially while our knowledge of the nature of the apperceptions of insects is so meager that we may hardly judge by what means they discover the flowers. That insects should make mistakes is no part of the theory ; it does not assume that the external showy parts should delay visitors or divert them from their proper course to the pollen or the nectar.

J. G. N.

ANTHROPOLOGY.

Man Past and Present.¹—This admirable treatise furnishes us with a much-needed text-book of ethnography. It is a continuation of the author's so-called *Ethnology* treating the varietal divisions of mankind "more in detail, with the primary view of establishing their independent specialization in their several geographical zones and at the same time elucidating the difficult questions associated with the origins and interrelations of the chief subgroups, and thus bridging over the breaks of continuity between *Man Past and Present*." Another object sought in this volume has been to emphasize the fundamental principles of anthropology: psychic unity, the factor of environment, and the significance of social and religious institutions. "From this point of view the present may be considered as a continuous illustration of the first volume, and students of such sociological subjects as the family, clan and tribe, totemic, matriarchal, and shamanistic usages, current views on primordial promiscuity and group marriages, early philosophies, theogonies, theories of the universe, assumed revelations involving sublime concepts of the Supreme Being in savage peoples of low cranial capacity, will here find some fresh materials not perhaps unworthy of their consideration." The two opening chapters deal in a summary way with origins and early migrations. Professor Keane restates his belief in a generalized proto-human form that overran the territory now occupied by the four primary divisions of mankind and from which they have sprung "by continuous adaptation to their several environments." The human character of the *Pithecanthropus erectus* remains is fully accepted and regarded as a true link between man and the generalized Simian prototype. No interval existed between the Old and the New Stone Ages. In the *Ethnology* Keane estimated the length of time that has elapsed since the beginning of the Neolithic Age at 100,000 years; he now questions whether this high figure ought not to be raised. The duration and relations of the Ages of Metal are briefly dealt with, and some account is given of the evolution of writing systems which usher in the Historical Period.

The main sections of the succeeding chapters are introduced by a conspectus of such salient features as: Primeval home; Present range; Physical characters; Mental characters; Main divisions.

¹ Keane, A. H. *Man Past and Present*. Cambridge, University Press, 1889. 584 pp., 8vo.

The terminology of the *Ethnology* is retained and the main divisions are designated "Ethiopic, Mongolic, American, and Caucasian." The Ethiopic division is considered in two groups—the African and Oceanic Negroes; the former includes the Sudanese and the Bantu-Negrito-Buschman-Hottentot tribes. The Oceanic Negroes are divided into sections—the Papuans, Australians, Tasmanians, and Negritoes. The Mongolic Branch is divided into the Southern, Oceanic, and Northern Mongols. The Americans are treated as a single race, fairly uniform in physical characters and mental traits, not indigenous in the absolute sense, since the human race is supposed to have originated in the Indo-Malaysian region, but resident in the New World since glacial times at least. Some attempt is made at subdividing the physical type into two groups—a dolichocephalic and a brachycephalic, the former including the Eskimos, Botocudos, and some others, the latter embracing the majority of the American aborigines, though the mean index is mesaticephalic (79). The long-headed division is derived from Proto-Europeans, the other division from Proto-Asiatics. The evidence adduced in the *Ethnology* in support of the belief that American culture has developed independently is restated with some additions.

The Eskimos are said to have ranged as far south as Massachusetts upon the evidence furnished by the Norse account. This describes the natives as "of small size, dark color, and broad features, using skin canoes (*hudh-keipr*) and harpoons unknown to the other natives, and eating a mixture of marrow and blood and what looked like raw meat." We grant that the Eskimos are shorter in stature, but they are not dark in color; on the contrary, they are very much lighter than the Indians. Their features are not so broad as those of the New England Indians; neither in bi-zygomatic, bi-maxillary, bi-jugal, nasal, or any other cranial breadth are they equal to the Algonquins. If the Eskimos in the time of Eric the Red indulged in raw flesh, marrow, and blood to any greater extent than did the Indians, there is absolutely no evidence to show that their descendants have done so. The grouping of all the long-headed Eskimos and Indians together (deriving them from a common European source) conveniently disposes of a perplexing problem, but with seemingly insufficient evidence.

The several Indian linguistic stocks are briefly described and the course of their migrations given so far as known. We note that the distribution of the Crees should be extended at least 1000 miles northwestward from the limits given by Keane. He criticises the

attempt made by American writers to generalize concerning the relations of the clan and gens from a study of American tribes alone; he shows that the matriarchal does not necessarily precede the patriarchal system in general, and that the clan "is still on defense even in North America."

Our author describes the temperament of the American aborigines as "moody, reserved, and wary"; we had supposed that this "conventional Indian" had been finally banished from scientific literature. The Indian doubtless exhibits such traits when in contact with the blight of civilization, but this is certainly not the case when he is among his kindred, as has been made known by several writers and as we have learned from personal observation among several tribes from the Arctic Sea to Mexico.

In the *Ethnology* no general divisions of the Caucasian race based upon physical structure were recognized, but in the present work the classification of Lapouge, Ripley, etc., is accepted and the entire branch is divided into the three groups: *Homo europaeus*, *H. alpinus*, and *H. mediterraneus*. Concerning the generalizations of the "anthropo-sociologists" Professor Keane states his belief that "a huge superstructure seems to have been built upon very weak foundations." The comprehensive character of the work involves the brief treatment of many disputed questions regarding origins and relationships, yet the evidence is submitted for the most part with fairness and in a lucid and convincing style. Twelve plates of portrait types are given, some of them being reproductions from photographs of apparently indifferent quality.

FRANK RUSSELL.

Anthropological Notes.—In a paper read before the Anthropological Society of Paris, Oct. 6, 1898, M. Paul d'Enjoy declared that the black color of the teeth of the Annamese is due to the application of "noir animal et de la poudre de calambac," the process requiring much time and patience and not the result of betel chewing, as is commonly supposed.

In the *Revue de l'École d'Anthropologie* of June 15 are reported the investigations of Dr. Chemin upon the occurrence of bluish or slaty spots on the skin of Mongolian infants. These marks have been observed among the Chinese of the bay of Kouan-cheou-Han, Annamites, Minh-huongs, Chinese-Siamese metis, and among the Siamese of Bangkok. The spots disappear about the sixth year.

Mr. F. W. Rudler, in his presidential address, published in the *Journal of the Anthropological Institute*, Vol. I, Nos. 3 and 4, gives

an entertaining summary of recent progress in anthropology. With reference to the publication of an epitome of the *World's Work in Anthropology* he says: "In no English journal have we a systematic review of anthropological literature in any way comparable, for instance, with the valuable collection of classified "Referate" in the *Archiv für Anthropologie*." "Experience, however, convinced me many years ago, when working on quite another subject, that it is practically impossible to organize a body of honorary contributors who can be relied upon for regular work of this kind." "Such work can never be systematically and satisfactorily done unless it is undertaken in a professional manner by a staff of paid contributors." The Address includes references to recent publications of unusual merit that awaken and extend a general interest in the science of anthropology.

In Vol. II, Part III, of the *Memoirs of the American Museum of Natural History* Mr. Harlan I. Smith describes the "Archæology of Lytton, British Columbia." No definite age is assigned to remains discovered, but some of them, at least, are several hundred years old. The conclusions reached by this careful observer are that the prehistoric culture of the region in question resembles that of the present inhabitants of British Columbia; slight differences are seen in the shape of the arrowheads, and in the ancient pipes which resemble those of Oregon and Washington. The style of the prehistoric carving suggests cultural relations with the Pacific coast tribes; the presence of seashells proves the occurrence of inter-tribal trade in the same direction. "On the whole, however, the prehistoric culture of the interior of British Columbia shows greater affinity to that of the western plateaus than to that of the North Pacific coast. Up to this time we have no evidence of a change of type or of a material change of culture since the earliest times of which we have knowledge."

In the *Annual Report* of the President of the American Museum of Natural History of New York for 1898 it is stated, in the account of the department of Anthropology, that "at no period in the history of this department has so much been done for its development or so many additions been made to its collections as during the present year." New laboratories and exhibition halls have been opened, and valuable collections from Central and South America have been installed. Of special interest are the specimens received from the parties engaged in the Jesup North Pacific Expeditions.

In the March number of *l'Anthropologie* W. L. H. Duckworth gives a brief account of a living anthropoid which he regards as an inter-

mediate form between the chimpanzee and the gorilla. "Johanna" has survived the vicissitudes of menagerie life for an unusually long period; she was kept in the zoölogical gardens at Lisbon for four years, was brought to America, and later was transported to England, where she has lived a year.

In the *American Antiquarian* for May appears "the first thorough, complete, and reasonably scientific investigation and description" of the quaternary deposits at Abbeville, France. The paper deals with the topography, fauna, and implements of the region.

O. T. Mason presents an admirable summary of "Aboriginal American Zoötechny" in the January *Anthropologist*. He divides the study into the following chapters: I, American Indian zoölogy, or ethno-zoölogy in America. II, Exploitive zoötechny—the activities associated with the capture and domestication of animals. III, Elaborative zoötechny—the activities practiced on the animal after capture. IV, Ultimate products of zoötechny and their relations to human happiness. V, Social organizations and corporations. VI, The progress of knowledge in zoötechny, including the growth of language. VII, Religion and the animal kingdom. The paper concludes with a table of the number of clans or gentes and the animal totems of the principal tribes.

In the April *Anthropologist* a timely article by Stewart Culin deals with the games of Hawaii; ninety-one in all are given, all amusements except the dance being included. Many of the ancient games have disappeared, yet the Hawaiians are a pleasure-loving people and have adopted many foreign amusements. The author says: "I have refrained from expressing any conclusions based on the material here presented. In general the games described may be referred to the continent of Asia or to recent European or American influence. There are several, however, which are more directly analogous to games played by the American Indians." A systematic comparison of these is promised in a forthcoming paper.

F. R.

ZOÖLOGY.

Nucleus of Mammalian Blood Corpuscles.—The blood of mammalian embryos, as is well known, contains numerous nucleated blood corpuscles. These in the adult give place to corpuscles which

after careful examination have been generally admitted to be non-nucleated. Within the last year or so Petrone has succeeded in demonstrating, by means of improved methods of fixing and staining, that the adult mammalian corpuscle contains a differentiated body which he believes to be the remains of a nucleus. This body has been the subject of a careful study by Negri,¹ who has satisfactorily identified it in the adult blood corpuscles of mammals, and who has also seen it in the blood of embryonic rabbits, where it exists in addition to the nucleus, thus showing that it is not to be regarded as the remains of an original nucleus.

G. H. P.

Development of the Teeth in Rodents. — The development of the teeth in rodents, as worked out by P. Adloff,² shows that the ancestors of these mammals possessed a more nearly complete dentition than do the present forms. Many species show the rudiment of a first incisor which eventually disappears, the characteristic incisor of the rodent being the second, as compared with the dentition of other mammals. This homology was previously declared by Cope, on paleontological grounds, and now receives support from the embryological side. In the upper jaws of some forms, as, for instance, *Sciurus*, a rudimentary canine was found, while in the corresponding region of the lower jaw not even a dental ridge was observed. The lower jaw may sometimes show evidence of prelacteal germs, thus marking the rodents as forms in which three generations of teeth once occurred. The paper is concluded with a short discussion of the question as to which generation the rodent molars belong.

G. H. P.

Breeding Habits of *Ornithorhynchus*. — Notwithstanding the efforts which have been made within very recent years to ascertain the breeding habits of *Ornithorhynchus*, very little in reality is known. W. H. Caldwell, in his search for the eggs and young of this animal, found one female that had laid her first egg and had the second still in the oviduct; R. Semon was altogether unsuccessful in obtaining further observations. In view of this lack of information, the field notes of A. Topič, as communicated by Professor V. Sixta,³

¹ Negri, A. Ueber die Persistenz des Kernes in den roten Blutkörperchen erwachsener Säugetiere, *Anat. Anzeiger*, Bd. xvi, pp. 33-38, 1899.

² Adloff, P. Zur Entwicklungsgeschichte des Nagetiergebisses, *Jenaische Zeitschrift*, Bd. xxxii, pp. 348-410, Taf. xii-xvi, 1898.

³ Sixta, V. Wie junge *Ornithorhynchi* die Milch ihrer Mutter saugen, *Zool. Anzeiger*, Bd. xxii, pp. 241-246. June 12, 1899.

are of special interest. According to this observer, *Ornithorhynchus* digs a burrow whose mouth lies below water level on the steep bank of a stream, and whose zigzag course leads to an enlarged nesting chamber at a level above high-water mark. The nest chamber is said to be as large as a platter and as high as a loaf of bread. The nest is lined with hair taken from the backs of the male and the female. On one occasion a nest was found with two eggs in it, both of which were unfortunately broken. At another time a female was observed suckling her two young. The female had no nipples. She lay on her back, and her young tapped with their bills about the small sieve-like openings of the mammary glands. The milk ran from these into a median groove on the skin formed by the longitudinal musculature, and from this groove the milk was taken by the young. The young remain in the nest till they attain a size of twelve centimeters, and when twenty centimeters in size they venture with the mother on the water.

G. H. P.

New Goby from Clipperton Island.—In the *Proceedings of the New England Zoölogical Club* for June 9, 1899, Vol. I, p. 63, Mr. Samuel Garman describes a new goby from Clipperton Island, off the west coast of Mexico, as *Gobius arundelii*. In the rather minute subdivision of genera adopted by Jordan and Evermann this species is probably referable to *Aboma*.

D. S. J.

The Chelæ of the Lobster.—The forms of the chelæ in lobsters have been reinvestigated by Stahr.¹ In the great majority of cases the European as well as the American lobster possesses two chelæ of typically different shapes. One is thin-walled, delicate, and provided with small teeth. The other is swollen and large, and has its biting surfaces covered with an irregular double row of knob-like eminences. The occurrence of these two forms of chelæ is not correlated with sexual differences or sides of the body. In the American form animals with both chelæ of the delicate type are of rare occurrence, but this condition is not so uncommon among the European lobsters. The delicate type of chelæ possesses teeth of four sizes arranged in eight-place intervals, and it may also carry an additional tooth not unlike those found on the heavier type of chela. Although the representatives of these two types are as a rule easily

¹ Stahr, H. Neue Beiträge zur Morphologie der Hummerschere mit physiologischen und phylogenetischen Bemerkungen, *Jenaische Zeitschrift*, Bd. xxxii, pp. 457-482, Taf. xx-xxi, 1898.

distinguishable, intermediate forms occur. The more delicate type is well supplied with tactile hairs.

The author believes the delicate type of chela to be the more primitive of the two. He rejects the explanation that it is a cutting jaw as contrasted with a crushing jaw, and believes that it represents an ornamental structure. The rhythmical arrangement of its teeth is dwelt upon, and he suggests that as a crustacean's eye plays over such a series it may receive agreeable impressions. The paper is well written in that the observational and theoretic parts are clearly separated.

G. H. P.

Cestodes of Aplacentalia.—Zschokke has just published¹ a most important article on the anoplocephaline cestodes, the immediate occasion of which was the examination of material brought from Celebes by the Sarasins. The specimens, fortunately well preserved, were taken from *Phalanger ursinus*, and represented two closely allied species of the genus *Bertia*. They proved to be new and were named *B. edulis* and *B. sarasinorum*. Regarding the specific name, *edulis*, Zschokke says that according to the report of the Sarasins, who obtained repeated and unimpeachable evidence of the fact, the tapeworms of *Phalanger* are hunted and eaten with gusto by the natives of Celebes. "Phalanger appears, by virtue of its parasites, to be subjected to more than one disadvantage!"

The anatomical structure of the two species is treated in detail. *B. edulis* is a large form, 660 mm. long with 1500 proglottids; *B. sarasinorum* has, on the contrary, a maximum length of 70 mm., with only 220 proglottids. Further differences are found in the manner of union of the excretory loops in the scolex, in the number, size, and arrangement of the sexual organs, and in many minor points, so that despite their similarity the two are undoubtedly good species. Closely related to them is *Tania obesa* from *Phascolarctus cinereus*, while somewhat similar are *T. echidnae* from *Echidna hystrix*, and *T. semoni* from *Perameles obesula*. Information on all of these forms comes from previous studies by Zschokke.² *T. festiva*, described in 1819 by Rudolphi from *Macroperus giganteus*, is undoubtedly an anoplocephaline form, probably of the genus *Moniezia*; it is only imperfectly known.

¹ Zschokke, F. Neue Studien an Cestoden aplacentaler Säugetiere, *Zeitschrift f. wiss. Zool.*, Bd. lxv, 3, pp. 404-445, Pls. xx, xxi, 1899.

² Die Cestoden der Marsupialia und Monotremata, *Semon, Zool. Forschungsreisen, Jenaische Denkschriften*, Bd. viii, 1898.

After an extensive and valuable discussion of the anatomical features of agreement and difference between the five species noted above, Zschokke enters upon a critical review of the subfamily Anoplocephalinae. Of family characters the so-called pyriform apparatus of the inner shell is certainly variable and available at most for the determination of species. On the other hand, the presence of three shells is clearly distinctive.

All cestodes yet described from aplacental mammals belong to the Anoplocephalinae, even those which are incompletely known. In that family these five species occupy a separate position, being clearly distinct from the Anoplocephalinae of ruminants and certain apes, the genera *Moniezia*, *Thysanosoma*, *Stilesia*, from those of many perissodactyles and some rodents, the genus *Anoplocephala*, and from those of rodents, the genera *Cittotænia* and *Andrya*. There remains for their reception only the heterogeneous genus *Bertia*, and with this the *obesa-edulis-sarasinorum* group agrees in main features, constituting a distinct natural subdivision of the genus. The group *echidnae-semoni* departs from *Bertia*, however, in not unimportant respects in which it is also unlike all other anoplocephaline cestodes, so that a new genus, *Linstowia*, is formed for these species. Prominent among the points characterizing it is the location of the vagina and *vas deferens* ventral to the longitudinal excretory canals and lateral nerve trunk, and of the narrow dorsal vessel marginal to the broad ventral vessel. In full agreement with repeated utterances of Stiles, Zschokke emphasizes here the taxonomic importance of the relative position of genital and excretory canals and longitudinal nerve trunks.

The diagnosis of the genus *Bertia* is rewritten in the light of this discussion and its species classed in three groups, of which only a single feature need be noted here. (a) Dorsal excretory canals remain actually dorsal to the ventral canals. Hosts, apes; species *B. mucronata* and *B. conferta* Meyner. (b) Dorsal canals lateral to ventral. Rodents. *B. americana* Stiles. (c) Dorsal canals mesal to ventral. Marsupials. *B. obesa*, *B. edulis*, *B. sarasinorum* Zschokke, and probably also *B. plastica* Sluiter from *Galeopithecus volans*. The type of the genus, *B. studeri* R. Bl., and *B. satyri* are so incompletely known that their position, as also the precise form of the genus, must remain at present uncertain.

For the new genus *Linstowia*, of which a summary diagnosis is also given, *L. echidnae* A. W. Thompson is taken as type, and *L. semoni* Zschokke also included. Noteworthy is the fact that Lin-

stowia, while resembling the different groups of the genus *Bertia*, in individual respects, is yet relatively furthest removed from that group which is found in marsupials.

In a summary the author notes that all *Tæniae* at present known from aplacental mammals belong to the subfamily *Anoplocephalinæ*, which is typical for herbivores, and are found in three genera, *Moniezia*, *Bertia*, *Linstowia*. Between the *Anoplocephalinæ* of placental and aplacental mammals there exists a certain anatomical parallel, corresponding to the similarity in their manner of life and nutrition. Pure herbivores, such as ruminants and the giant kangaroo, harbor the genus *Moniezia*. The marsupials, *Phascolarctus*, *Phalanger*, as also the placental *Galeopithecus*, live on leaves, fruits, and rarely also on insects; in them is parasitic a well-circumscribed subgroup of the genus *Bertia*. Finally the aplacental insectivores, *Echidna* and *Perameles*, are inhabited by a special genus *Linstowia*, for which a parallel from *Placentalia* is not at present known.

H. B. W.

Histology and Physiology of the Gastræadæ.—Under this head T. Garbowski¹ describes the results of some recent observations on *Trichoplax adherens* F. E. Schulze, on which he bases certain theoretical conclusions.

He finds the body epithelia covered with a several-layered cuticle, through which project the cilia. Contrary to the statement of Schneider, these cilia are not continuous within the cytoplasm, but, as is shown by impregnation with gold chlorid, are merely outer processes of the cells. It is conclusively shown that the ventral epithelium possesses no digestive power. This function is assumed by certain cells of the loose body parenchyma. Undoubtedly only liquid food is assimilated, chiefly organic decomposition products. Other cells of the parenchyma, becoming fibrous in character, take a dorso-ventral arrangement and act as muscles. The so-called muscles of von Graff appear as artifacts under the action of certain chemical reagents.

The large spheres, regularly arranged in the parenchyma and usually described as fat bodies, are shown to be the intercellular excretory products of the animal and are closely comparable to the excretory vacuoles of the larger amoebæ. Those other yellowish brown globules, which have been variously interpreted as otoliths, spermatoblasts, etc., are more probably specimens of a symbiotic alga, *Zooxanthella*.

¹ Zur Histologie und Physiologie der Gastræaden, *Bull. Internat. de L'Académie des Sciences de Cracovie*, February, 1899, pp. 87-98.

There has also been observed in *Trichoplax* a most interesting process of conjugation, in which two individuals become joined so completely as to leave no trace of the point of fusion. This process is preparatory to mechanical fission or architomy. That it always precedes this reproduction is yet to be proved. No other method of generation has been observed.

From the above facts is drawn the conclusion that *Trichoplax* cannot, as has been claimed by the advocates of Haeckel's *Gastraea* theory, be considered as a flattened gastrula. Neither is it related to the *Plathelmintha*, as stated by Böhmig, since the acelous condition of certain *Turbellaria* is secondary, but that of *Trichoplax* is evidently ancestral.

The author considers it unnatural to place *Trichoplax* and the closely allied *Treptoplax* in a special group, the *Placuleadæ*, and to set them as the simplest type of the multicellular animals, *Protaccelia*, at the foot of the metazoan stem. It is claimed that the mere fact that the *Protaccelia* are not hypothetical, like the *Gastraea*, but really exist, is in itself disproof of Haeckel's *gastral* phylogeny; that there is danger that the advocates of this theory, in their zeal for proof of the minutiae may neglect the broader facts of development, which point so evidently to a varied origin of the Metazoa.

Trichoplax then, while it does not support the *Gastraea* theory, may yet serve as an important factor in the development of the true theory of metazoan embryology.

HARRISON S. ALLEN.

Notes.—*Gephyrea*, collected at Christmas Island, Indian Ocean, are described by Shipley (*Proc. Zool. Soc.*, London, Jan. 17, 1899). Of the six species listed only one, *Thalasema baronii* Greef, is rare. In the same paper, *Physcosoma japonicum* Grube is reported from the coast of British Columbia, though previously known only from the western shores of the Pacific Ocean.

The supposed occurrence of *Synganus trachealis*, the gape worm, in the domestic duck, as recorded by various authors, has been definitely shown by Railliet (*Arch. Parasit.*, Vol. I, No. 4, pp. 626, 627) to be due to the mistranslation of an English letter!

Recent work on the *Myxosporidia* is the subject of a comprehensive review by Doflein (*Zool. Centralbl.*, Vol. I., pp. 361-379). Of great general importance is noted the opinion of the author that with better knowledge of both groups this order is approaching the *Rhizopoda*.

In the *Proceedings of the Academy of Natural Sciences of Philadelphia* for 1899 (p. 179) Mr. Henry A. Fowler describes a small collection of fishes sent to the academy from Tan-lan-ho River in China. The new species are: *Leuciscus farnumi*, *Leuciscus costatus*, *Nemachilus dixoni*, and *Nemachilus pechiliensis*. Mr. Fowler also (p. 118) publishes a short list of fishes of Jamaica in collections in Philadelphia. Of the twenty-five species none are new, although two or three are not common in collections.

The belated concluding number of Vol. XIV of the *Journal of Morphology*, dated September, 1898, has just appeared and contains the following articles: Budding in Perophora, by G. Lefevre; On the Morphology of Certain of the Bones of the Cheek and Snout of *Amia Calva*, by E. P. Allis, Jr.; The Location of the Basis of the Amphibian Embryo, by A. C. Eycleshymer; and The Cocoons and Eggs of Allolobophora *Fætida*, by Katharine Foot.

The last number of the *Journal of Comparative Neurology*, Vol. IX, No. 2, contains, besides the usual editorial and literary notices, Nerve Termini in the Skin of the Common Frog, Part I, by G. E. Coghill; The Number and Arrangement of the Fibres forming the Spinal Nerves of the Frog, by Irving Hadesly; The Total Number of Functional Nerve Cells in the Cerebral Cortex of Man, and the Percentage of the Total Volume of the Cortex composed of Nerve Cell Bodies, calculated from Karl Hammarberg's Data, together with a Comparison of the Number of Giant Cells with the Number of Pyramidal Fibres, by H. B. Thompson; A Note on the Significance of the Small Volume of the Nerve Cell Bodies in the Cerebral Cortex of Man, by H. H. Donaldson.

BOTANY.

Weber's Cacti in Bois's Dictionnaire d'Horticulture.¹—The compiler of this dictionary was fortunate in securing, as one of the many associate editors, Dr. Albert Weber as the authority for the order Cactaceæ. This was a wise selection in view of the fact that in all probability no other man to-day has such rich opportunities for studying the order, or has given so much careful consideration to it as Dr. Weber.

¹ Bois, D. *Dictionnaire d'Horticulture*. Paris, 1893. 4to.

As a surgeon in the French army during its occupation of Mexico he traveled in nearly every part of that country, and was always busy making observations and notes on the cacti. On his subsequent return to France he gathered together, in the gardens of Mr. Robert Roland Gosselin, a large collection of these plants, not only from Mexico, but from other countries as well; and with these he continued his study of the order, until now he is justly considered one of the best, if not the first authority on this family of plants. He was a constant correspondent of the late Dr. George Engelmann, the acknowledged American authority on the order, and their free exchange of opinions and of specimens was of invaluable aid to each.

Since a botanist would hardly expect to find original descriptions in a horticultural dictionary, it seems wise that these published by Dr. Weber be brought more conspicuously before the botanical public, and to that end they are here appended. The dictionary, not as yet completed, has thus far been issued in *livraisons* of thirty-two pages each. The date of issue of each *livraison*, as far as published, has been kindly furnished in a letter from the author, and the date given in the citation of the species is made to correspond.

Anhalonium trigonum Weber in Bois's *Dictionnaire d'Horticulture*, 90, June, 1893. This, in compliance with the rules of nomenclature, becomes *Ariocarpus trigonus* K. Sch. *Cereus Pasacana* Web. l.c. 281, published some time between Feb. 1894 and Feb. 1895; the exact date is not known. This enormous *Cereus* is the giant of the Argentine Cordilleras, as *Cer. giganteus* is that of the Mojave desert. *Echinocactus heterochromus* Web. l.c. 466, Sept. 1896. *Echino.* *Peninsule* Web. l.c. 467, Sept. 1896. *Echino.* *Saussieri* Web. l.c. 468, Sept. 1896. *Echino.* *microspermus* Web. l.c. 469, Sept. 1896. *Echino.* *Schickendantzii* Web. l.c. 470, Sept. 1896. *Mamillaria plumosa* Web. l.c. 804, Jan. 1898. *Mam. valida* Web. l.c. 806, Jan. 1898. *Opuntia hyptiacantha* Web. l.c. 894, April, 1898. *Op. myriacantha* Web. l.c. 894, April, 1898. *Op. pilifera* Web. l.c. 894, April, 1898. *Op. Quipa* Web. l.c. 894, April, 1898. *Op. quitensis* Web. l.c. 894, April, 1898. *Op. ursina* Web. l.c. 896, April, 1898. In this the specific name is suggested by the dense covering of long, coarse hair-like spines, which also give it the universally accepted common name of "Grizzly Bear Cactus." *Op. australis* Web. l.c. 896, April, 1898. *Op. Schickendantzii* Web. l.c. 898, May, 1898. *Op. Spegazzinii* Web. l.c. 898, May, 1898. *Pereskia Argentina* Web. l.c. 938, July, 1898. *Per. Guanacho* Web. l.c. 938, July, 1898. *Per. panamensis* Web. l.c. 939, July, 1898. *Per.*

tampicana Web. l.c. 939, July, 1898. *Per. Philippii* Web. l.c. 939, July, 1898. *Phyllocactus phyllanthus* Link. vars. *boliviensis* Web., *paraguayensis* Web., and *columbiensis* Web. l.c. 957, July, 1898.

Besides these descriptions of new species, Dr. Weber makes a number of new combinations in nomenclature which are here given, with sufficient synonymy only for identification. *Anhalonium turbiniforme* Web. (*Echino. turbiniformis* Pfeif.) in Bois's *Dict. d'Hort.*, 90, June, 1893. *Echinocactus latispinus* Web. (*Echino. cornigerus* DC.; *Cactus latispinus* Haw.) l.c. 467, Sept. 1896. *Echinopsis catamarcensis* Web. (*Cer. catamarcensis* Web.) l.c. 471, Sept. 1896. *Echinopsis minuscula* Web. (*Echino. minusculus* Web.) l.c. 471, Sept. 1896. *Echinopsis obrepanda* Web. (*Echino. obrepandus* Web.) l.c. 472, Sept. 1896. *Echinopsis Schickendantzii* Web. (*Cer. Schickendantzii* Web.) l.c. 473, Sept. 1896. *Mamillaria pectinifera* Web. (*Pelecyphora acelliformis* Ehrenb. var. *pectinata* Hort.) l.c. 804, Jan. 1898. *Opuntia cereiformis* Web. (*Grusonia cereiformis* Hort., *Cer. Bradtianus* Coult.) l.c. 897, May, 1898. *Op. spathulata* Web. (*Pereskia spathulata* Otto) l.c. 899, May, 1898. *Pereskia Amapola* Web. (*Per. horrida* Parodi., *Per. Bleo* Morong) l.c. 938, July, 1898. *Pfeiffera ianthothele* Web. (*Pf. cereiformis* Salm., *Cer. ianthothele* Monv.) l.c. 944, July, 1898.

C. H. T.

Fertilization of Cycas.—An important recent paper by Professor S. Ikeno,¹ of Tokyo, Japan, treats of the development of the sexual products and the process of fertilization in *Cycas revoluta*. Incidentally it throws light on the relationships of the Cycads, but its chief interest lies in its bearing on the general problems of cell structure and fertilization.

In the development of the archegonia within the endosperm, Ikeno distinguishes three periods corresponding with those which are recognized in the development of animal sexual products. These are:

1. A period of *division*, in which the archegonial cells are differentiated.
2. A period of *growth*, during which the central cell (egg-cell) of the archegonium attains a relatively enormous size, its nucleus alone being 75-120 mikra in diameter. The growth takes place at the expense of cells which surround the central cell, their nuclei being actively engaged in the formation of granular food substance which is passed on into the central cell through pores in the intervening cell walls.

¹ *Journal of the College of Science, Imperial University, Tokyo*, vol. xii, Pt. iii, pp. 151-214; Pls. X-XVII.

This is exactly parallel with what takes place in the growth of the shark's egg at the expense of its follicle cells, and reminds us also of similar processes in insect eggs.

3. A *maturation* period, in which the central cell is prepared for fertilization. This consists in a very unequal-cell division, resulting in the formation of a small canal cell which rests as a small cap on the peripheral end of the large, oval egg-cell.

Pollination occurs in June or July, and is shortly followed by the formation of the pollen tube at about the same time that the archegonium is being differentiated. The changes which take place in the pollen tube leading to the formation of motile spermatozoa cover a period of two months or more, at the end of which period fertilization is accomplished, in September or October.

A pollen grain is spherical in form, containing three cells placed in a row, namely, a large "embryonal cell" and two small flattened "prothallium cells." The embryonal cell plays the principal part in the formation of the pollen tube, occupying a position near its growing tip, the prothallium cells meanwhile remaining quiescent at the opposite end of the tube. Having formed the pollen tube, which now lies imbedded in the endosperm, the embryonal cell seems to have performed its principal function, and it subsequently disintegrates.

The larger prothallium cell, the one which was next to the embryonal cell in the pollen grain, may be regarded as a primordial germ cell; it now begins to develop, passing successively through stages of division, growth, and maturation, corresponding to those which occur in animal spermatogenesis. In the first of these stages nuclear division occurs without division of the cytoplasm, one of the nuclei being thrown out into the pollen tube as the "Stielzelle."

Early in the second, or growth period, centrosomes appear in the germinal cell (spermatocyte, to use the terminology of animal spermatogenesis) on opposite sides of the nucleus. These are very large deeply staining bodies, which persist throughout the subsequent development and have an interesting fate. The spermatocyte attains a diameter of about 0.14 mm., its large nucleus being about 60 mikra in diameter, and the centrosomes 10-15 mikra (!) in diameter. The centrosomes, except for a few vacuoles which they contain, are solid structures, as is shown by the fact that they can be broken into fragments by pressure. Around them are seen faint cytoplasmic radiations.

Maturation is accomplished by the completion of the division

foreshadowed by the presence of the centrosomes during the growth period. Two hemispherical spermatids are thus formed, each containing a large nucleus and centrosome. Each spermatid metamorphoses into a motile (ciliated) spermatozoon of about the shape of the spermatozoon of *Ascaris*, so well known to zoologists. During this metamorphosis the centrosome resolves itself into an elongated band-like structure in the cytoplasm; from one side of it radiations are seen projecting. A process of the nucleus is for a long time directed outward toward the deep end of this band, indicating that the nucleus is concerned in the changes which are taking place. The centrosome band ultimately comes to lie in a long spiral of about five turns just under the curved surface of the cell. The cytoplasmic radiations emerge from the surface as a spiral band of cilia, which remain attached to the centrosome band as to a basal plate; they form the locomotor apparatus of the spermatozoon. The greater part of the mature spermatozoon consists of a large nucleus, which is covered with a thin but perfectly distinct layer of cytoplasm, in which lies the centrosome band bearing the cilia.

Ikeno regards the centrosome band as homologous with the middle piece of the animal spermatozoon, the centrosome being known to pass into the middle piece in animal spermatogenesis; the cilia he regards as corresponding with the flagellum of animal spermatozoa. In fertilization a spermatozoon makes its way through the fluid which has accumulated around the egg-cell, bores into the egg-cell and loses its cilia and cytoplasm, after which its nucleus moves toward the oval egg nucleus, sinking into a ready formed depression (*Empfängnissöhle*) on its peripheral end. The sperm and egg nuclei now fuse completely, no centrosome being visible during the process, nor in the nuclear division which follows. In this division the spindle fibers do not converge at either end of the mitotic figure, but lie parallel with each other throughout their whole length. The entire absence of centrosomes during fertilization is strongly in contrast to what is known of fertilization in animals.

W. E. C.

Botrytis and its Host.—The relation of *Botrytis* to its host plants has recently been studied by Nordhausen.¹ With some preliminary account of the infection of living plants by this fungus through the surface of wounds, whereby by reason of the injured cells *Botrytis* may readily begin its usual saprophytic existence, he passes to

¹ Nordhausen, M. *Beiträge zur Biologie parasitärer Pilze, Jahrb. f. Wissenschaft, Botanik*, Bd. xxxiii, pp. 1-46.

the consideration of the infection of uninjured tissue. By means of injecting into plants water containing *Botrytis* spores, it was possible to note the effect of their germination far removed from the point of injury. He found that from the time when the spores in the inter-cellular spaces began to produce any sign of hyphae, the near-by cells showed evidence of disorganization. The cell walls turned brown and ultimately also the cell contents, until eventually death of the affected parts ensued. By numerous experiments he arrived at the conclusion that this is due to the secretion of a poison by the germinating spore. Into the cells so killed the *Botrytis* mycelium can now readily make its way, and by further excretion of the poisonous substance spread, mayhap, through the whole tissue of the plant. According to the author, it is by this means alone that *Botrytis* is able to assume its apparently true parasitic habit, although the hyphae cannot penetrate the living cells themselves. Experiments with *Penicillium* showed that this fungus has no such power of killing cells on which it is growing; in other words, that it does not secrete a poisonous substance, and can only penetrate cells which themselves are in a weakened or diseased condition. The relation of *Botrytis* to its host is simple compared with that of a true parasite, which usually induces complicated hypertrophies. With *Botrytis* it is simply a question of killing the cells to effect an entrance in the first place, and a continuance of this process to effect a further development of the fungus. A large class of plant diseases must be included under the same head. Under natural conditions, where infection takes place through an injured surface, the spread of the fungus resolves itself into the question as to whether the host plant can form an impermeable covering of wound cork faster than the hemiparasite can destroy the cells around the point of infection.

H. M. R.

Notes.—No. 15 of the new series of *Contributions from the Gray Herbarium*, by M. L. Fernald, deals with certain species of *Eleocharis* and *Scirpus*, and is published as No. 19 of the current volume of the *Proceedings of the American Academy of Arts and Sciences*.

A conspectus of the genus *Lilium* is published by Professor Waugh in the *Botanical Gazette* for April.

“Grazing Problems in the Southwest” and “*Poa Fendleriana* and its Allies” are the titles of two recent papers by J. G. Smith, published from the Division of Agrostology of the United States Department of Agriculture.

New fossil North American mosses are described by Kirchner in the eighth volume of the *Transactions of the Academy of Science of St. Louis*, and Mrs. Britton in the *Bulletin of the Torrey Botanical Club* for February.

A comparative general study of the seedlings of certain woody plants, and of the anatomy of the hypocotyl and epicotyl, is printed by Francis Ramaley in a recent number of *Minnesota Botanical Studies*.

Nevada and other Weed Seeds is the title of a bulletin, by F. H. Hillman, recently issued from the Nevada Experiment Station.

PETROGRAPHY.

Herrmann's Quarry Industry and Quarry Geology¹ is an elementary text-book on the composition and character of the rocks used for construction and ornamental purposes and on the methods employed in exploiting and finishing quarry products. It describes briefly the methods used in testing the strength and wearing qualities of building stones and gives a short account of the present condition of the quarry business.

So far as the discussion goes it is simple and straightforward, so that it may easily be comprehended by any one who possesses some little knowledge of mineralogy and geology.

The most interesting portion of the book is that devoted to the rocks quarried in Saxony. This comprises about 220 pages. It begins with a short description of the geology of Saxony. This is followed by a few pages of statistics, and then come descriptions of the different rocks quarried in the kingdom, with a statement of their scientific and technical characteristics, and remarks concerning their use.

Most commendable features of the volume are its excellent bibliography of scientific and technical works on minerals and rocks, its lists of Saxon dealers in museum material, of laboratories for the

¹ *Steinbruchindustrie und Steinbruchgeologie. Technische Geologie nebst praktischen Winken für die Verwertung von Gesteinen unter eingehender Berücksichtigung der Steinindustrie des Königreiches Sachsen, etc.*, von Dr. O. Herrmann. Berlin, Gebrüder Borntraeger, 1899. xvii + 428 pp. Pl. VI; Fig. 17.

testing of building stones, of the museums and collections of minerals and rocks within the limits of the kingdom, and of articles in the geology of Saxony.

W. S. B.

Notes.—The lavas of the early Tertiary volcanoes¹ of the Absaroka range on the east side of the Yellowstone National Park consist of a repeated succession of hornblende and micaceous andesites, basalts, pyroxene, andesites, and finally a series of great flows of basalts. With these are associated immense deposits of tuffs, agglomerates, and igneous conglomerates.

Cushing² describes the augite-syenite gneiss near Loon Lake in the Adirondack district, New York, as medium grained, grayish green rocks composed of feldspar, pyroxene or hornblende, quartz, and sometimes biotite or garnet. They are undoubtedly metamorphosed intrusive rocks that are intimately associated with gneisses of sedimentary origin. The feldspar is usually a microperthite, but there are usually present in all slides small quantities of oligoclase. The pyroxene is principally augite, but hypersthene is often associated with it. The quartz is in elongated cylindrical individuals. The rocks are autoclastic in structure and are also foliated. In composition they are close to akerite.

SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	FeO	CaO	BaO	MgO	K ₂ O	Na ₂ O	P ₂ O ₅	Loss	Tot.
63.45	.07	18.31	.42	3.56	2.93	.13	.35	5.15	5.06	tr.	30	= 99.73

It is plain from the analysis that the augite is essentially a calcium, ferrous, aluminous variety unusually rich in alumina. The microperthite is approximately $Or_3 AC_5$. The syenite is thought to be closely related in origin to the anorthosite of the district.

Baallow³ gives excellent descriptions of some of the handsome autoclastic conglomerates met with in the Grenville and Hastings series of Ontario. They resemble very closely true conglomerates, but their genesis from banded rocks by dynamic agencies is clearly traced. The illustrations accompanying the descriptions are particularly interesting.

Pirsson⁴ collected together in a few pages the evidence that points to the conclusions that the phenocrysts of intrusive rocks are often formed in place, and are not intratelluric. The reasons for this con-

¹ Presidential Address of Arnold Hague, *Geol. Soc. of Washington*, 1899.

² *Bull. Geol. Soc. of America*, vol. x, p. 177.

³ *Ottawa Naturalist*, vol. xii, p. 205, 1899.

⁴ *Amer. Jour. Sci.*, vol. vii, p. 271, 1899.

clusion are briefly as follows: porphyritic intrusive masses often possess peripheral portions completely devoid of phenocrysts; dykes connected with large intrusions may be free from phenocrysts, while the mass of the intrusions is filled with them; flat crystals are often arranged haphazard in sheet and dykes and not in obedience to any law of flowage; phenocrysts often enclose crystals identical with those composing the matrix which surrounds them, and, finally, phenocrysts are often surrounded by microlites orientated parallel to the bounding faces of the large crystal, indicating that the latter was growing after the former had crystallized.

The conditions governing the consolidation and crystallization of igneous rocks are decrease in temperature, chemical composition of the magma, the influence of mineralizing vapors, pressure and increasing viscosity. In the view of the author "the greatest determinant in the formation of rock structure is the ratio of time in the fall of temperature between the point where the insolubility and crystallizing moment of a compound begins to the increasing viscosity."

The Inwood limestone¹ in the northern part of Manhattan Island is cut by pegmatite dykes, some of which are well exposed a few blocks north of Fort George. Near the contact the limestone contains tremolite, biotite, and brown tourmaline, while the last-named mineral occurs also in the peripheral portion of the pegmatite.

¹ Eckel. *Amer. Geologist*, vol. xxiii, p. 122, 1899.

NEWS.

DR. ARTHUR HOLICK, of New York, is to complete the monograph, *The Later Extinct Floras of the United States*, left unfinished at the death of Professor Newberry. The plates were printed some time ago, and include the cretaceous and tertiary floras of the west.

Among the scientific expeditions of the present summer we note that of Professor J. C. Branner to study the coral reef of Brazil; two sent out by the American Museum (New York) to collect fossils in our western states; Dr. J. L. Wortman visits Wyoming to collect fossils for the Carnegie Museum in Pittsburg; Mr. Harrington and Mr. Sumner revisit Egypt in the hopes of obtaining the embryology of *Polypterus*; Professor W. A. Setchell goes with a party of botanists to Alaska to study the flora; the University of New Mexico will study the geology, botany, zoölogy, and ethnology of that territory; the Union Pacific Railroad invites 300 geologists to conduct geological investigations in the neighborhood of their lines; Mr. Alexander Agassiz, with a party of assistants, will spend several months in the study of the deep seas and the coral reefs of the South seas, the U. S. Fish Commission steamer *Albatross* being placed in his charge; Professor Libbey goes with a party from the University of Princeton to Greenland and will conduct deep-sea dredgings in the Arctic seas; an expedition from the University of Chicago to explore the ruins in the vicinity of Merida, Yucatan; Professor Charles E. Bessey studies the flora of western Nebraska; Professor John Macoun investigates the flora of Sable Island; Dr. John N. Rose goes to Mexico to investigate several points in economic botany; Drs. Trelease, Fernald, Coville, and Saunders visit Alaska under the invitation of Mr. E. H. Harriman; Dr. Luigi Buscaloni, of Turin, goes on a botanical expedition to the lower Amazon region; Alexis A. B. Birula, of St. Petersburg, goes as zoölogist with the Russian expedition which is to measure an arc of a meridian on the island of Spitzbergen.

Dr. Anton Dohrn, of Naples, and Dr. Melchior Treub, of Buitenzorg, Java, have been elected foreign members of the Royal Society.

The statue to Darwin in the museum of the University of Oxford was unveiled on June 14, the ceremony being preceded by an address by Sir Joseph Hooker.

A compromise has been effected by which the Academy of Natural Sciences of Philadelphia receives one-half of the bequest of \$300,000 left it by the late Dr. Robert Lamborn.

Vassar College has been promised \$25,000 towards a biological laboratory on condition that another similar amount be raised for the same purpose.

The death of Dr. Axel Gœs, of Stockholm, Sweden, which occurred in August, 1887, has remained unchronicled in scientific journals until recently. He was well known for his researches on Crustacea and Rhizopods. He was 62 years of age.

Professor Douglas H. Campbell, of Leland Stanford University, and Dr. B. M. Duggar, of Cornell University, will spend the coming year in Europe.

Appointments to Fellowships: Johns Hopkins University: Lawrence Edmonds Griffin, zoölogy; Joseph Cawdell Herrick, physiology; George Burr Richardson and Richard Burton Rowe, geology. Bryn Mawr: Miss Elizabeth Towle, biology. Tufts College: Mr. Harrison S. Allen and Mr. George F. Morton, biology.

The following appointments in zoölogy have been made at Harvard University: Dr. F. W. Bancroft, Parker Fellowship; H. W. Rand, Virginia Barrett Gibbs Scholarship. C. W. Prentiss, S. R. Williams, and W. A. Willard have been appointed assistants in zoölogy.

H. M. Benedict, formerly Fellow in zoölogy at the University of Nebraska, has been chosen head of the Biological Department of the Nebraska State Normal at Peru.

Emerson E. McMillin has given the Ohio Academy of Science \$250 with which to carry on scientific investigations, and declared his intention of giving the same amount annually, if the money is wisely expended. During the last session of the legislature, the academy put forth strong efforts to secure an appropriation for a topographic survey of the state to be undertaken in coöperation with the U. S. Geological Survey. The bill passed the Senate, but did not come to a vote in the House.

Appointments: Marshall A. Barber, associate professor of cryptogamic botany in the University of Kansas. — Miss Annie I. Barrows, assistant in zoölogy in Smith College. — Dr. George A. Bates, professor of histology in the Tufts College Dental School. — Mr. John G. Coulter, instructor in botany in Syracuse University. —

Dr. Deichmüller, of mineralogical and ethnological museum at Dresden, titular professor.—Dr. Julius Doeger, adjunct of the Austrian Geological Survey.—Mr. Ulysses S. Grant, professor of geology in Northwestern University.—Dr. R. G. Harrison, associate professor of anatomy in the Johns Hopkins University.—Dr. Herbertson, lecturer on physical geography in the University of Oxford.—Dr. F. D. Lambert, instructor in biology in Tufts College.—Dr. Frank R. Lillie, of the University of Michigan, professor of biology in Vassar College.—Dr. Florence M. Lyon, assistant in botany in Smith College.—Mr. Harold Lyon, assistant in botany in the University of Minnesota.—Dr. E. B. Matthews, associate professor of petrography and mineralogy in the Johns Hopkins University.—Dr. Elisa Norsa, assistant in the zoölogical cabinet of the University of Bologna.—Miss Winnifred J. Robinson, instructor in biology in Vassar College.—Dr. C. Schenck, docent for anthropology and ethnology in the University of Lausanne.—Dr. G. B. Shattuck, associate in physiographic geology in the Johns Hopkins University.—Mr. John Louis Sheldon, assistant in botany in the University of Nebraska.—Max Standfuss, docent in entomology, titular professor in the University of Zürich.—Dr. Franz Edouard Suess, assistant on the Austrian Geological Survey.—Mr. W. H. Wheeler, assistant in botany in the University of Minnesota.—Dr. J. L. Wortman, of the American Museum of Natural History in New York, curator of the department of geology and paleontology in the Carnegie Museum of Pittsburg, Pa.

Deaths: Franz Benteli, entomologist, in Bern, Switzerland, January 28, aged 75.—Dr. Otto Böckeler, a student of the genus *Carex*, in Varel, Oldenburg, March 5, aged 95.—Dr. Ludwig Büchner, titular professor and the author of *Force and Matter* and similar works, in Darmstadt, April 30, aged 75.—Carl Jonas Reinhold Elgenstjerna, botanist, in Nora, Sweden, March 25.—Charles Stuart Gregson, an English student of Lepidoptera, January 31, aged 81.—Friedrich Heppe, geologist, in Pretoria, South Africa, Aug. 8, 1898.—Dr. Theodor von Hessling, formerly professor of anatomy in the University of Munich, May, aged 83.—Dr. Joseph Armin Knapp, assistant in the botanical department of the Court Museum of Vienna, April 1.—Rev. James Digues La Touche, geologist, in Stockesay, England, February 24, aged 74.—Gottlieb William Leitner, a student of Asiatic anthropology, in Bonn, February 22, aged 58.—Dr. Giovanni Michelotti, paleontologist, at Turin, Italy, December 21, aged 84.—

Dr. Naudrad, bryologist, in Tahiti, November, 1898.—Dr. William Nylander, lichenologist, in Paris, March 29, aged 77.—Paolo Mach di Palmstein, student of Italian algæ, in Fiume, Italy, January 5, aged 28.—Dr. August Römer, conservator of the Natural History Museum in Wiesbaden, May 1, aged 74.—Joseph Stevens, geologist, in London, April 7, aged 81.—Dr. Thomas O. Summers, professor of anatomy in the St. Louis College of Physicians and Surgeons, January 19.

PUBLICATIONS RECEIVED.

(The regular exchanges of the *American Naturalist* are not included.)

BIRCH, DE BURGH. A Class Book of (Elementary) Physiology, including Histology, Chemical and Experimental Physiology. Philadelphia, Blakiston, 1899. x, 273 pp., 8vo, 62 figs.—BATHER, F. A. The Genera and Species of Blastoidea, with a List of the Specimens in the British Museum. x, 70 pp.—CRAGIN, BELLE S. Our Insect Friends and Foes. New York, Putnam's, 1899. xix, 377 pp., 255 figs.—SCHUMANN, K. Morphologische Studien. Heft ii. Leipzig, Engelmann, 1899. pp. 207-313, 6 figs. 7 marks.

DALL, W. H. Synopsis of the Recent and Tertiary Leptonocea of North America and the West Indies. *Proc. U.S. Nat. Mus.* Vol. xxi, pp. 873-897. Pls. LXXXVII, LXXXVIII.—GARMAN, S. Concerning a Species of Lizard from Clipperton Island. *Proc. N.E. Zoöl. Club.* Vol. i, pp. 59-62. June.—GARMAN, S. A Species of Goby from the Shores of Clipperton Island. *Proc. N.E. Zoöl. Club.* Vol. i, pp. 63, 64. June.

American Microscopical Society, Transactions of. Vol. xx, 369 pp. May.—*Georgia State Board of Entomology.* Bulletin No. 1. April. W. M. Scott, I, Legislation against Crop Pests; II, Dangerous Pests Described by the Board with Remedial Suggestions. 32 pp., 2 figs.—*Insect World, The.* Vol. iii, No. 5. May.—*Michigan Ornithological Club Bulletin.* Vol. iii, No. 2. April.—*Ohio State Academy of Science.* Seventh Annual Report.—*Ohio State Academy of Science.* Special Papers No. 1. Moseley, E. L., Sandusky Flora. A Catalogue of the Flowering Plants and Ferns, etc. 167 pp.—*Ohio State Academy of Science.* Special Papers No. 2. Kellicott, D. S., The Odonata of Ohio. A Descriptive Catalogue of the Dragonflies Known in Ohio, etc. vii, 114 pp. Plates and portrait.—*Rhode Island Agricultural Experiment Station.* Eleventh Annual Report.

(No. 392 was mailed Aug. 19.)

